Clark

The Effect Of Certain Electrolytes On The Viscosity Of Clay Suspensions

THE EFFECT OF CERTAIN ELECTROLYTES ON THE VISCOSITY OF CLAY SUSPENSIONS

BY

HAROLD EDWARD CLARK

THESIS

FOR THE

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IN

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

HAROLD EDWARD CLARK

ENTITLED THE EFFECT OF CERTAIN ELECTROLYTES ON THE VISCOSITY OF CLAY SUSPENSIONS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF BACHELOR OF SCIENCE IN CERAMICS

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THE EFFECT OF CERTAIN ELECTROLYTES ON THE VISCOSITY OF CLAY SUSPENSIONS

INTRODUCTION

The purpose of the following investigation has been to determine the effect of the addition of certain electrolytes on the viscosity of clay suspensicns.

Electrolytes are known to differ in their action on different clays, depending on the physical structure and chemical composition of the clay to which they are added. The action of an electrolyte on a clay may be one of 1) flocculation, by which a coarsening or sedimentation of the disperse particles is produced, 2) deflocculation, by which the size of the disperse particles decrease, thus causing them to settle more slowly, and 3) flocculation and deflocculation, depending on the concentration of the electrolyte used. Ashley[1] states that, "To say a substance is in the colloid state with reference to water is equivalent to the statement that the substance is dispersed throughout the water to form particles of which the diameter may range all the way from molecular up to microscopic and macrosopic dimensicns. The properties exhibited by the system vary with the fineness of the particles (the degree of dispersion); consequently the phenomena produced in disperse systems by the addition of reagents - apart from purely chemical effects - are due to variation in the degree of dispersion produced by the change of

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[1]Technical Control of the Colloidal Matter of Clays, Bull. 23, U.S. Bureau of Standards, p. 15.

circumstances." The action of an electrolyte as a deflocculating agent and then with increasing concentration of the salt, as a flocculating agent Ashley[2] attributes to the fact that "the bases which conserve coagulation (that is, form less soluble gels) are removed by a double decomposition and form the more soluble alkali salt, thus promoting deflocculation. Addition of a larger amount of the salt may produce a recoagulation, which is caused by the diminution of solubility consequent upon the increased concentration of the common iron (salting-out action). Such added salts will also react with any soluble salts present with the clay; this may complicate matters and will render necessary the addition of a larger amount of salt than would be required for deflocculation if soluble salts were absent." Also[3], "The alkali reacts with the constituents of the clay and forms an alkali silicate or aluminosilicate which in solution is hydrolyzed to some extent, so that a part of it is present as a sol. Further addition of alkali increases the amount of sodium salt in solution and in the sol state up to a certain point at which an increase of the alkali concentration begins to set back the hydrolysis and to cause a diminution in the amount of sol. This process goes on progressively until at a certain concentration most of the clay is again coagulated."

The time factor must also be considered in the treatment

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[2]Ibid., p. 66.

[3]Ibid., p. 64.

[illegible]

of clays with electrolytes, as a period of several hours is usually necessary for the attainment of a comparatively stable state of viscosity. For this reason the effects of 24 hours and of 48 hours standing was investigated in this work in order to allow the salts to attain their nearly maximum or minimum action in a reasonable time.

In the ceramic industries a knowledge of disperse systems is of great value in the casting of pottery ware. The casting process consists in pouring a thick water suspension of the body into Plaster of Paris molds, the plaster absorbing water from the slip. A coating of the clay body of the desired shape is thus formed on the surface of the mold. It is therefore of great importance that a minimum amount of water be used in the slip, so as to prevent excessive shrinkage and cracking of the ware on drying. The water content may be lowered by the addition of certain electrolytes. Bleininger[4] states that "The principal effect of the alkaline additions to a casting slip is to decrease the amount of water required to hold unit weight of the clay in the suspended state with sufficient fluidity to permit of pouring. The practical aim in casting must be to increase the weight of clay body carried by unit volume of the water to the maximum."

The present investigation was undertaken to study the effect of a number of commonly used electrolytes upon the viscosity of some typical American kaolins and ball clays in order to

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[4]Use of Sodium Salts in the Purification of Clays and in the Casting Process, Bull. 51, U. S. Bureau of Standards, p. 19, 20.

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observe the difference in action of each electrolyte upon each of the clays.

METHOD

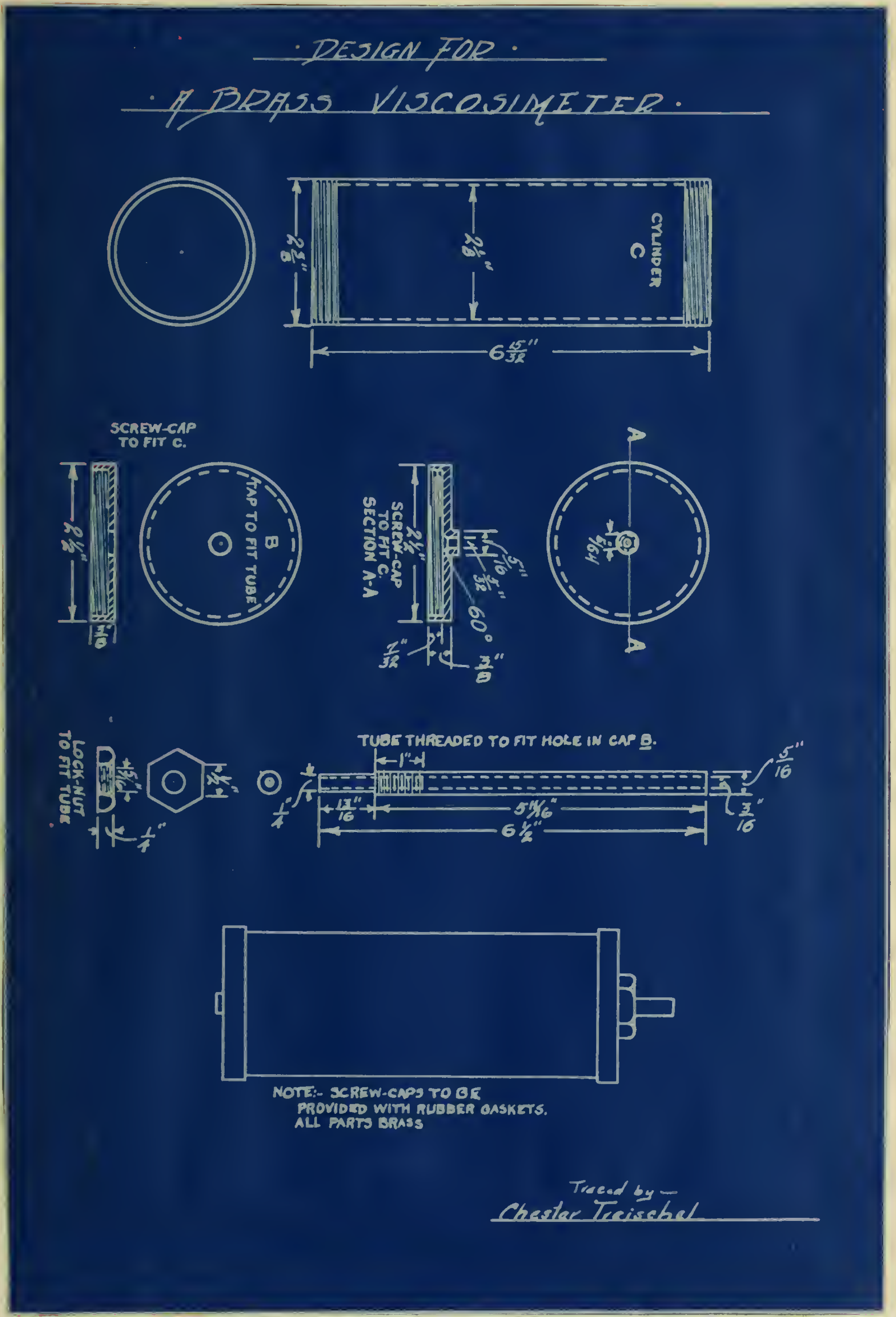
In this work the effects of NaOH, NaCl, Na_2CO_3, Na_2SO_4, $AlCl_3$, $Al_2(SO_4)_3$, $MgSO_4$, $CaCl_2$, and HCl upon the viscosity of slips of Georgia kaolin, Delaware kaolin, Florida kaolin, North Carolina kaolin, and Tennessee Ball Clay #1 were tested.

For the purpose of testing the viscosity of the slips a brass efflux viscosimeter as illustrated in Fig. 1 was used. The time required for 200 cc. of the slip to flow through the orifice of the viscosimeter was determined by means of a stop watch. The time required for 200 cc. of water to flow through the orifice was also observed and by dividing the time of flow of the slip by the time of flow of an equal volume of water the viscosity of the slip in terms of water was computed.

The clay was screened to 40 mesh and then dried at 110° C. for 4 hours in an electric oven. Samples were then weighed out and the minimum amount of water necessary to cause 200 cc. of the slip to flow through the viscosimeter in from 25.6 to 27.6 seconds was determined. Then to the dry clay samples the electrolyte was added in amounts of 0, 0.0625, 0.25, 0.50, 0.75, 1.00, 0.125, and 1.25 per cents by weight to the dry clay. Water was added up to the amount previously determined and the samples were shaken on the revolving shaker for one hour.

Viscosity tests were made on all the samples after one hour of shaking, and after standing for 24 and 48 hours. Two or more check tests were made in all cases, and the results given in the tables have all been checked at least once to insure their accuracy.

FIGURE 1.



·DESIGN FOR·
·A BRASS VISCOSIMETER·
CYLINDER C
SCREW-CAP TO FIT C.
B TAP TO FIT TUBE
SCREW-CAP TO FIT C. SECTION A-A
60°
TUBE THREADED TO FIT HOLE IN CAP B.
LOCK-NUT TO FIT TUBE
NOTE:- SCREW-CAPS TO BE PROVIDED WITH RUBBER GASKETS. ALL PARTS BRASS
Traced by — Chester Treischel

NaOH in Ga. Kaolin

% by Weight of NaOH in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip contained 33⅓% Clay
0.0625	25.2	1.077	25.2	1.077	26.4	1.128	Time of Flow of Water=23.4 Seconds
0.125	26.0	1.111	25.2	1.077	26.0	1.111	
0.25	34.4	1.470	31.6	1.350	30.8	1.316	
0.50	Too Viscous	to Flow	Too Viscous	to Flow	Too Viscous	to Flow	
0.75	" "	" "	" "	" "	" "	" "	
1.00	" "	" "	" "	" "	" "	" "	
1.25	27.6	1.179	30.4	1.299	34.4	1.470	

NaCl in Ga. Kaolin

% by Weight of NaCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip contained 33⅓% clay
0.0625	25.2	1.077	25.6	1.094	25.6	1.094	Time of Flow of Water=23.4 Sec.
0.125	24.8	1.059	24.8	1.059	24.8	1.059	
0.25	25.2	1.077	26.0	1.111	26.0	1.111	
0.50	25.6	1.094	26.4	1.128	26.8	1.145	
0.75	26.4	1.128	27.6	1.179	28.0	1.196	
1.00	26.8	1.145	27.6	1.179	28.0	1.196	
1.25	27.2	1.162	28.0	1.196	28.4	1.214	

$MgSO_4$ in Ga. Kaolin

% by Weight of $MgSO_4$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip contained 33⅓% clay
0.0625	26.0	1.111	26.4	1.128	26.4	1.128	Time of Flow of Water = 23.4 Sec
0.125	26.0	1.111	26.4	1.128	26.0	1.111	
0.25	26.0	1.111	26.0	1.111	26.4	1.128	
0.50	26.2	1.119	26.0	1.111	26.0	1.111	
0.75	26.4	1.128	26.4	1.128	26.8	1.145	
1.00	26.6	1.136	26.4	1.128	26.4	1.128	
1.25	26.4	1.128	26.4	1.128	27.0	1.153	

$AlCl_3$ in Ga. Kaolin

% by Weight of $AlCl_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip contained 33⅓% clay
0.0625	26.0	1.111	26.0	1.111	26.0	1.111	Time of Flow of Water = 23.4 Sec
0.125	25.8	1.103	25.8	1.103	25.8	1.103	
0.25	25.6	1.094	25.6	1.094	26.0	1.111	
0.50	25.6	1.094	25.4	1.085	25.4	1.085	
0.75	25.6	1.094	25.4	1.085	25.4	1.085	
1.00	25.2	1.077	25.2	1.077	25.8	1.103	
1.25	25.0	1.068	25.0	1.068	25.6	1.094	

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Na_2CO_3 IN GA. KAOLIN

% BY WEIGHT OF Na_2CO_3 IN TERMS OF DRY CLAY	AFTER 1 HOUR SHAKING		AFTER 24 HOURS STANDING		AFTER 48 HOURS STANDING		REMARKS
	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	SLIP CONTAINED 33⅓% CLAY
0.0625	25.6	1.094	28.0	1.196	28.0	1.196	TIME OF FLOW OF WATER = 23.4 SEC.
0.125	25.2	1.077	27.4	1.171	27.4	1.171	
0.25	25.2	1.077	26.8	1.145	26.8	1.145	
0.50	30.4	1.299	30.4	1.299	29.8	1.273	
0.75	34.8	1.487	34.2	1.461	33.2	1.419	
1.00	33.2	1.419	32.6	1.393	32.4	1.384	
1.25	40.2	1.718	35.6	1.521	35.4	1.513	

Na_2SO_4 IN GA. KAOLIN

% BY WEIGHT OF Na_2SO_4 IN TERMS OF DRY CLAY	AFTER 1 HOUR SHAKING		AFTER 24 HOURS STANDING		AFTER 48 HOURS STANDING		REMARKS
	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	SLIP CONTAINED 33⅓% CLAY
0.0625	25.6	1.094	27.6	1.179	27.2	1.162	TIME OF FLOW OF WATER = 23.4 SEC.
0.125	25.6	1.094	27.6	1.179	27.2	1.162	
0.25	26.0	1.111	27.6	1.179	27.4	1.171	
0.50	26.4	1.128	27.8	1.188	27.6	1.179	
0.75	27.2	1.162	28.2	1.205	28.0	1.196	
1.00	27.2	1.162	28.2	1.205	28.0	1.196	
1.25	27.2	1.162	28.4	1.213	28.2	1.205	

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$Al_2(SO_4)_3$ IN GA. KAOLIN

% by Weight of $Al_2(SO_4)_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip Contained 33⅓% clay
0.0625	25.6	1.094	25.8	1.103	26.0	1.111	Time of Flow of Water = 23.4 Sec.
0.125	25.6	1.094	26.0	1.111	26.2	1.119	
0.25	25.6	1.094	25.8	1.103	26.0	1.111	
0.50	25.6	1.094	25.6	1.094	25.8	1.103	
0.75	25.4	1.085	25.4	1.085	25.6	1.094	
1.00	25.2	1.077	25.6	1.094	25.8	1.103	
1.25	25.2	1.077	25.6	1.094	26.0	1.111	

$CaCl_2$ IN GA. KAOLIN

% by Weight of $CaCl_2$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip Contained 33⅓% clay
0.0625	25.6	1.094	25.8	1.103	25.8	1.103	Time of Flow of Water = 23.4 Sec.
0.125	25.8	1.103	25.8	1.103	25.8	1.103	
0.25	25.8	1.103	25.8	1.103	25.8	1.103	
0.50	25.8	1.103	25.8	1.103	25.8	1.103	
0.75	25.6	1.094	25.6	1.094	25.6	1.094	
1.00	25.6	1.094	25.6	1.094	25.6	1.094	
1.25	25.4	1.085	25.4	1.085	25.4	1.085	

HCl in Ga. Kaolin

% by Weight of HCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	25.6	1.094	25.6	1.094	25.6	1.094	Slip Contained 33⅓% clay
0.0625	26.0	1.111	26.6	1.136	26.6	1.136	Time of Flow of Water=23.4 Sec
0.125	26.2	1.119	26.6	1.136	26.6	1.136	
0.25	26.2	1.119	26.6	1.136	26.6	1.136	
0.50	26.2	1.119	26.6	1.136	26.6	1.136	
0.75	26.8	1.145	27.4	1.171	27.4	1.171	
1.00	27.2	1.162	27.2	1.162	27.2	1.162	
1.25	27.6	1.179	27.8	1.188	27.8	1.188	

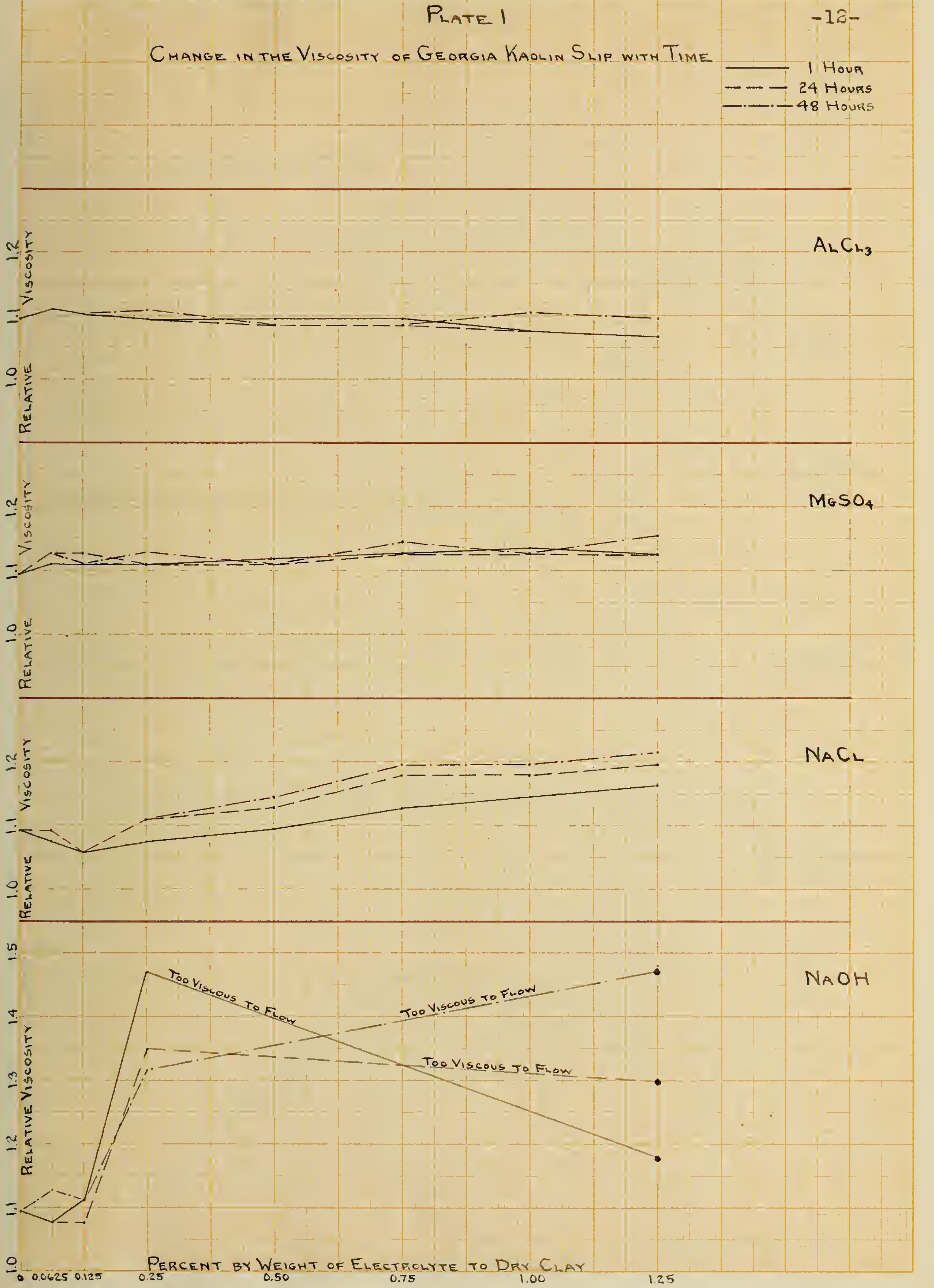
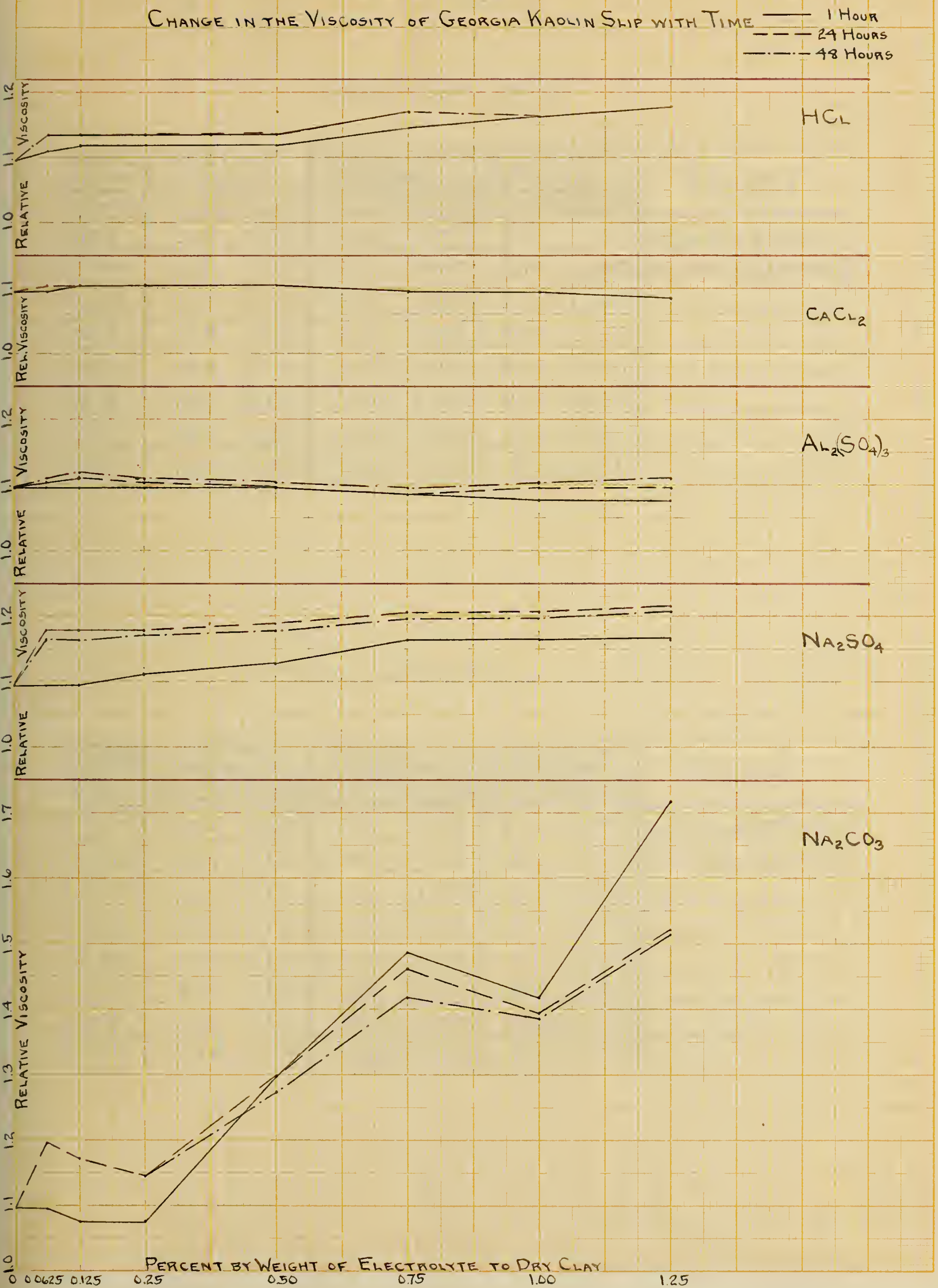


Plate I
Change in the Viscosity of Georgia Kaolin Slip with Time
1 Hour
24 Hours
48 Hours
AlCl3
MgSO4
NaCl
NaOH
Relative Viscosity
1.0
1.1
1.2
1.3
1.4
1.5
Too Viscous to Flow
Too Viscous to Flow
Too Viscous to Flow
Percent by Weight of Electrolyte to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

PLATE 2


CHANGE IN THE VISCOSITY OF GEORGIA KAOLIN SLIP WITH TIME
1 HOUR
24 HOURS
48 HOURS
HCL
CACL$_2$
AL$_2$(SO$_4$)$_3$
NA$_2$SO$_4$
NA$_2$CO$_3$
RELATIVE VISCOSITY
REL. VISCOSITY
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
PERCENT BY WEIGHT OF ELECTROLYTE TO DRY CLAY
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

NaOH in Del. Kaolin

% by Weight of NaOH in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% Clay
0.0625	25.2	1.077	25.4	1.085	24.8	1.059	Time of Flow of Water = 23.4 Seconds
0.125	25.0	1.068	25.2	1.077	24.4	1.043	
0.25	25.4	1.085	25.4	1.085	24.8	1.059	
0.50	25.8	1.103	25.8	1.103	25.0	1.068	
0.75	25.8	1.103	26.2	1.119	25.2	1.077	
1.00	26.6	1.136	26.6	1.136	26.0	1.111	
1.25	26.8	1.145	26.6	1.136	26.0	1.111	

NaCl in Del. Kaolin

% by Weight of NaCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip contained 33⅓% clay
0.0625	27.4	1.171	27.4	1.171	27.4	1.171	Time of Flow of Water = 23.4 Sec.
0.125	27.4	1.171	27.2	1.162	26.8	1.145	
0.25	27.2	1.162	27.2	1.162	27.2	1.162	
0.50	27.0	1.153	27.0	1.153	27.0	1.153	
0.75	27.4	1.174	27.2	1.162	27.0	1.153	
1.00	27.2	1.162	27.0	1.153	26.8	1.145	
1.25	27.0	1.153	27.0	1.153	26.8	1.145	

$MgSO_4$ IN DEL. KAOLIN

% by Weight of $MgSO_4$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% clay
0.0625	28.0	1.196	27.8	1.188	27.4	1.171	Time of Flow of Water=23.4 Sec.
0.125	27.8	1.188	27.2	1.162	26.8	1.145	
0.25	27.6	1.179	27.6	1.179	27.6	1.179	
0.50	27.8	1.188	27.8	1.188	27.8	1.188	
0.75	28.0	1.196	27.8	1.188	27.8	1.188	
1.00	28.0	1.196	27.8	1.188	27.8	1.188	
1.25	27.8	1.188	27.8	1.188	27.8	1.188	

$AlCl_3$ IN DEL. KAOLIN

% by Weight of $AlCl_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% clay
0.0625	28.8	1.231	28.6	1.222	28.4	1.214	Time of Flow of Water=23.4 Sec.
0.125	32.6	1.393	30.6	1.308	30.0	1.282	
0.25	39.6	1.692	35.6	1.521	35.2	1.504	
0.50	46.6	1.991	43.0	1.837	47.0	2.008	
0.75	45.4	1.940	42.6	1.821	45.8	1.957	
1.00	41.8	1.786	40.2	1.718	42.4	1.812	
1.25	41.0	1.752	39.6	1.692	40.2	1.718	

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Na_2CO_3 in Del. Kaolin

% by Weight of Na_2CO_3 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip contained 33⅓% clay
0.0625	26.6	1.136	26.0	1.111	25.6	1.094	Time of Flow of Water=23.4 Sec.
0.125	25.4	1.085	25.2	1.077	24.8	1.059	
0.25	24.8	1.059	24.8	1.059	24.6	1.051	
0.50	25.0	1.068	25.0	1.068	24.8	1.059	
0.75	25.0	1.068	24.8	1.059	25.0	1.068	
1.00	25.0	1.068	25.0	1.068	25.0	1.068	
1.25	25.0	1.068	25.0	1.068	25.2	1.077	

Na_2SO_4 in Del. Kaolin

% by Weight of Na_2SO_4 in Terms of Dry Clay	After 1 Hours Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip contained 33⅓% clay
0.0625	27.8	1.188	27.4	1.171	27.0	1.153	Time of Flow of Water=23.4 Sec.
0.125	27.4	1.171	27.2	1.162	26.6	1.136	
0.25	27.4	1.171	27.2	1.162	26.6	1.136	
0.50	26.4	1.128	26.4	1.128	26.2	1.119	
0.75	26.4	1.128	26.4	1.128	26.4	1.128	
1.00	26.2	1.119	26.2	1.119	26.2	1.119	
1.25	26.0	1.111	26.0	1.111	26.0	1.111	

$Al_2(SO_4)_3$ in Del. Kaolin

% by Weight of $Al_2(SO_4)_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00.	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% clay
0.0625	28.0	1.196	27.8	1.188	27.4	1.171	Time of Flow of Water = 23.4 Sec.
0.125	29.4	1.256	28.2	1.205	27.8	1.188	
0.25	32.8	1.402	31.6	1.350	30.6	1.308	
0.50	35.4	1.513	35.4	1.513	35.2	1.504	
0.75	35.8	1.529	35.8	1.529	36.0	1.538	
1.00	35.4	1.513	35.4	1.513	36.0	1.538	
1.25	33.2	1.419	35.8	1.529	36.2	1.547	

$CaCl_2$ in Del. Kaolin

% by Weight of $CaCl_2$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% clay
0.0625	27.8	1.188	28.0	1.196	28.0	1.196	Time of Flow of Water = 23.4 Sec.
0.125	28.0	1.196	28.0	1.196	28.2	1.205	
0.25	28.0	1.196	28.0	1.196	28.0	1.196	
0.50	28.0	1.196	28.0	1.196	28.0	1.196	
0.75	28.0	1.196	28.0	1.196	28.0	1.196	
1.00	28.0	1.196	28.0	1.196	28.0	1.196	
1.25	28.0	1.196	28.0	1.196	28.0	1.196	

HCl in Del. Kaolin

% by Weight of HCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 33⅓% clay
0.0625	27.8	1.188	27.8	1.188	27.8	1.188	Time of Flow of Water = 23.4 Sec.
0.125	28.8	1.231	28.2	1.205	28.2	1.205	
0.25	29.2	1.248	28.8	1.231	28.8	1.231	
0.50	29.6	1.265	29.6	1.265	29.6	1.265	
0.75	30.0	1.282	31.0	1.325	31.2	1.333	
1.00	30.8	1.316	31.6	1.350	31.6	1.350	
1.25	30.6	1.308	31.4	1.342	31.4	1.342	

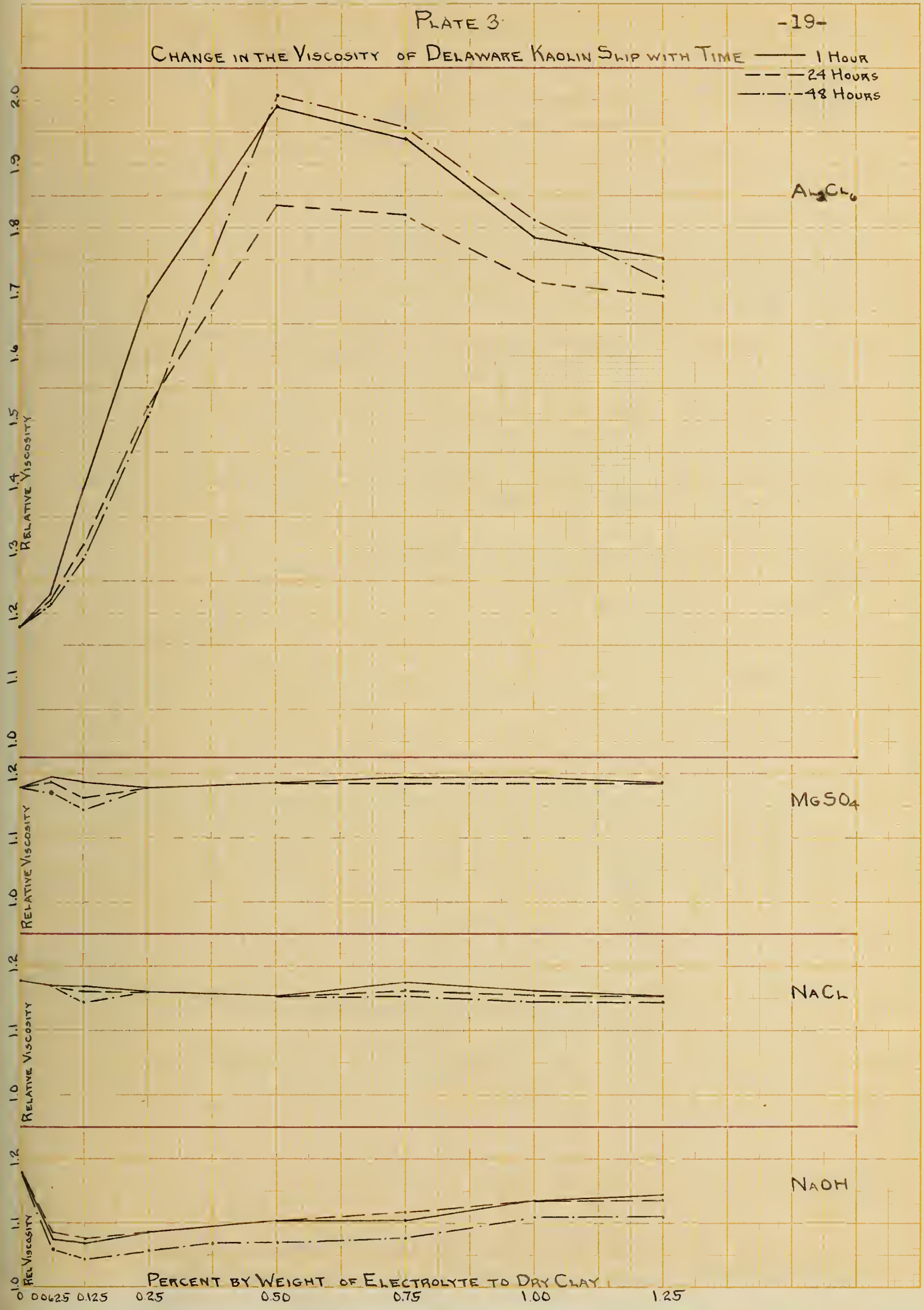
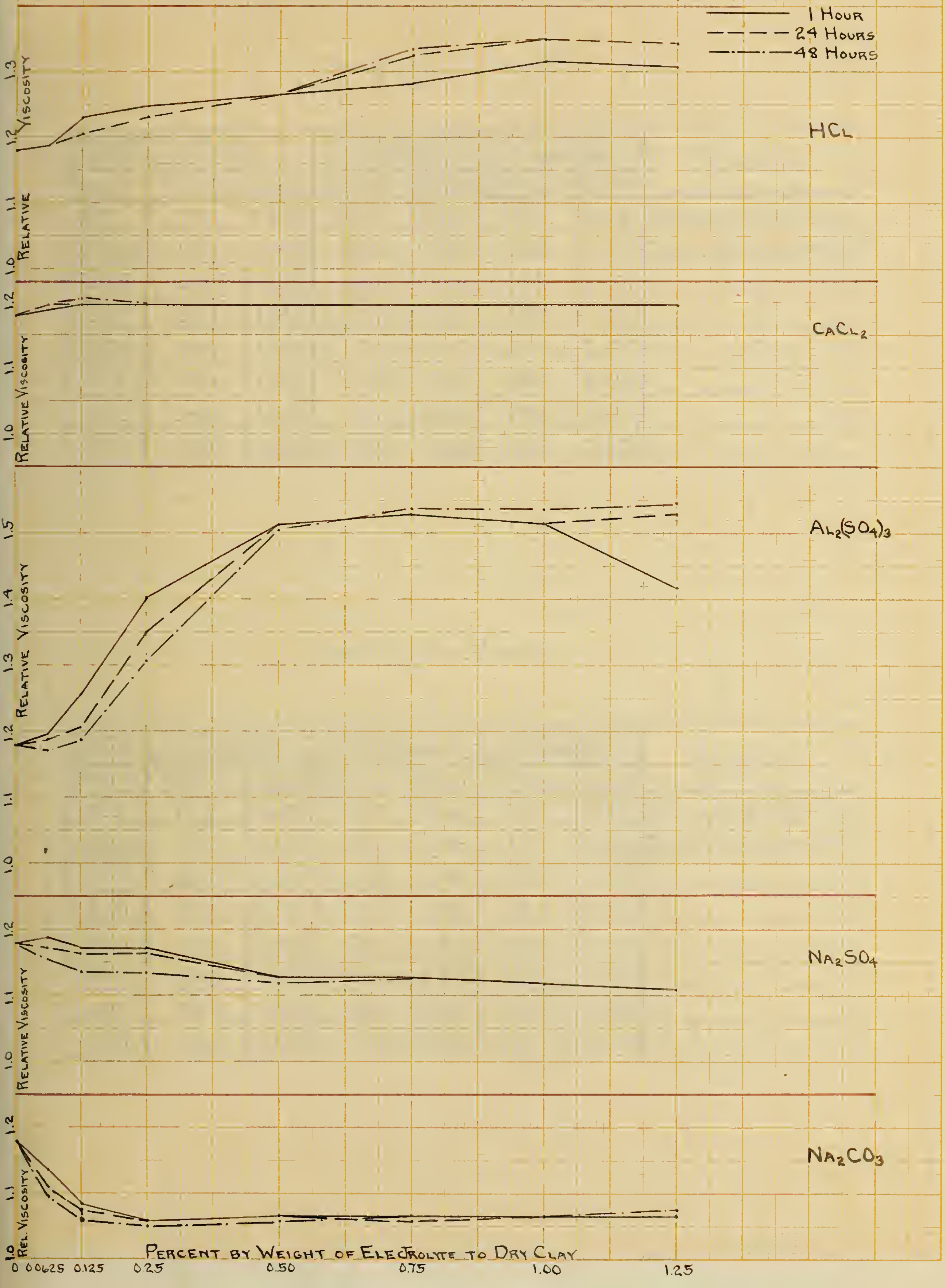


Plate 3
Change in the Viscosity of Delaware Kaolin Slip with Time
1 Hour
24 Hours
48 Hours
Al_2Cl_6
$MgSO_4$
NaCl
NaOH
Relative Viscosity
Rel. Viscosity
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
Percent by Weight of Electrolyte to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

Plate 4

Change in the Viscosity of Delaware Kaolin Slip with Time



NaOH in Fla. Kaolin

% by Weight of NaOH in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip contained 26⅔% Clay
0.0625	26.8	1.145	26.8	1.145	26.8	1.145	Time of Flow of Water = 23.4 Seconds
0.125	24.0	1.026	24.0	1.026	24.6	1.051	
0.25	24.4	1.043	24.4	1.043	24.0	1.026	
0.50	24.4	1.043	24.4	1.043	24.2	1.034	
0.75	24.4	1.043	24.4	1.043	24.0	1.026	
1.00	24.6	1.051	24.6	1.051	24.6	1.051	
1.25	25.0	1.068	25.0	1.068	25.0	1.068	

NaCl in Fla. Kaolin

% by Weight of NaCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% Clay
0.0625	27.2	1.162	27.0	1.153	27.0	1.153	Time of Flow of Water = 23.4 Sec.
0.125	27.0	1.153	26.8	1.145	26.8	1.145	
0.25	26.6	1.136	26.6	1.136	26.8	1.145	
0.50	26.6	1.136	26.6	1.136	26.8	1.145	
0.75	26.6	1.136	26.6	1.136	26.8	1.145	
1.00	26.6	1.136	26.6	1.136	26.8	1.145	
1.25	26.4	1.128	26.6	1.136	26.6	1.136	

$MgSO_4$ in Fla. Kaolin

% by Weight of $MgSO_4$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	26.6	1.136	26.4	1.128	26.4	1.128	Time of Flow of Water = 23.4 Sec.
0.125	27.0	1.153	27.0	1.153	27.0	1.153	
0.25	27.0	1.153	27.0	1.153	27.0	1.153	
0.50	27.0	1.153	27.0	1.153	27.0	1.153	
0.75	27.0	1.153	27.2	1.162	27.2	1.162	
1.00	26.8	1.145	27.0	1.153	27.2	1.162	
1.25	26.8	1.145	27.0	1.153	27.2	1.162	

$AlCl_3$ in Fla. Kaolin

% by Weight of $AlCl_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	26.8	1.145	26.6	1.136	26.4	1.128	Time of Flow of Water = 23.4 Sec.
0.125	27.0	1.153	27.0	1.153	26.8	1.145	
0.25	27.2	1.162	27.0	1.153	26.8	1.145	
0.50	27.2	1.162	27.0	1.153	27.0	1.153	
0.75	27.2	1.162	27.0	1.153	27.0	1.153	
1.00	27.2	1.162	27.0	1.153	27.0	1.153	
1.25	27.2	1.162	27.0	1.153	27.0	1.153	

Na_2CO_3 in Fla. Kaolin

% by Weight of Na_2CO_3 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	27.0	1.153	26.6	1.136	26.4	1.128	Time of Flow of Water = 23.4 Sec.
0.125	26.6	1.136	26.2	1.119	25.6	1.094	
0.25	26.4	1.128	26.2	1.119	25.8	1.103	
0.50	25.2	1.077	25.0	1.068	24.8	1.059	
0.75	24.8	1.059	24.6	1.051	24.4	1.043	
1.00	24.6	1.051	24.2	1.034	24.2	1.034	
1.25	24.4	1.043	24.4	1.043	24.4	1.043	

Na_2SO_4 in Fla. Kaolin

% by Weight of Na_2SO_4 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	25.4	1.085	25.2	1.077	25.0	1.068	Time of Flow of Water = 23.4 Sec.
0.125	25.4	1.085	25.2	1.077	25.0	1.068	
0.25	25.0	1.068	25.2	1.077	25.2	1.077	
0.50	25.2	1.077	25.2	1.077	25.2	1.077	
0.75	25.8	1.103	26.2	1.119	26.2	1.119	
1.00	25.8	1.103	26.0	1.111	26.0	1.111	
1.25	26.2	1.119	26.4	1.128	26.4	1.128	

$Al_2(SO_4)_3$ in Fla. Kaolin

% by Weight of $Al_2(SO_4)_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	25.6	1.094	25.6	1.094	26.0	1.111	Time of Flow of Water = 23.4 Sec.
0.125	26.0	1.111	26.0	1.111	26.0	1.111	
0.25	26.8	1.145	27.2	1.162	27.2	1.162	
0.50	27.6	1.179	27.4	1.171	27.4	1.171	
0.75	27.6	1.179	27.6	1.179	27.6	1.179	
1.00	27.0	1.153	27.0	1.153	27.0	1.153	
1.25	26.8	1.145	26.8	1.145	26.8	1.145	

$CaCl_2$ in Fla. Kaolin

% by Weight of $CaCl_2$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	Slip Contained 26⅔% clay
0.0625	24.8	1.059	24.8	1.059	25.0	1.068	Time of Flow of Water = 23.4 Sec.
0.125	24.6	1.051	24.8	1.059	25.0	1.068	
0.25	24.6	1.051	24.8	1.059	24.8	1.059	
0.50	24.8	1.059	24.8	1.059	24.8	1.059	
0.75	24.8	1.059	24.8	1.059	24.8	1.059	
1.00	24.8	1.059	24.8	1.059	24.8	1.059	
1.25	24.8	1.059	24.8	1.059	24.8	1.059	

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HCL IN FLA. KAOLIN

% BY WEIGHT OF HCL IN TERMS OF DRY CLAY	AFTER 1 HOUR SHAKING		AFTER 24 HOURS STANDING		AFTER 48 HOURS STANDING		REMARKS
	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	
0.00	27.2	1.162	27.2	1.162	27.2	1.162	SLIP CONTAINED 26⅔% CLAY
0.0625	26.4	1.128	26.4	1.128	26.6	1.136	TIME OF FLOW OF WATER=23.4 SEC
0.125	26.8	1.145	27.2	1.162	27.6	1.179	
0.25	26.8	1.145	27.0	1.153	27.0	1.153	
0.50	28.2	1.205	28.2	1.205	28.2	1.205	
0.75	28.8	1.231	28.4	1.214	28.6	1.222	
1.00	29.6	1.265	29.0	1.239	29.2	1.248	
1.25	28.4	1.214	28.0	1.196	28.0	1.196	

PLATE 5

CHANGE IN THE VISCOSITY OF FLORIDA KAOLIN SLIP WITH TIME

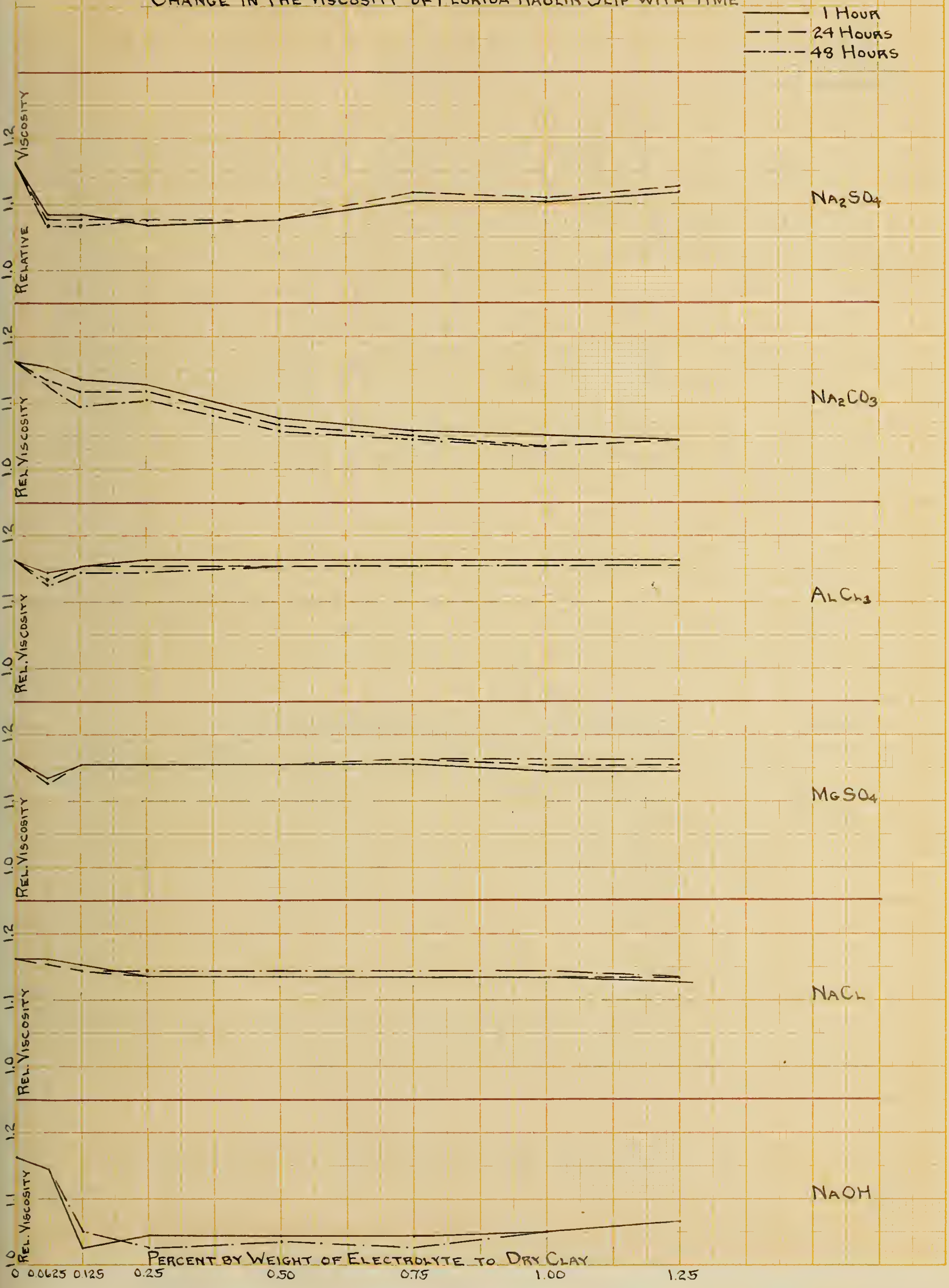
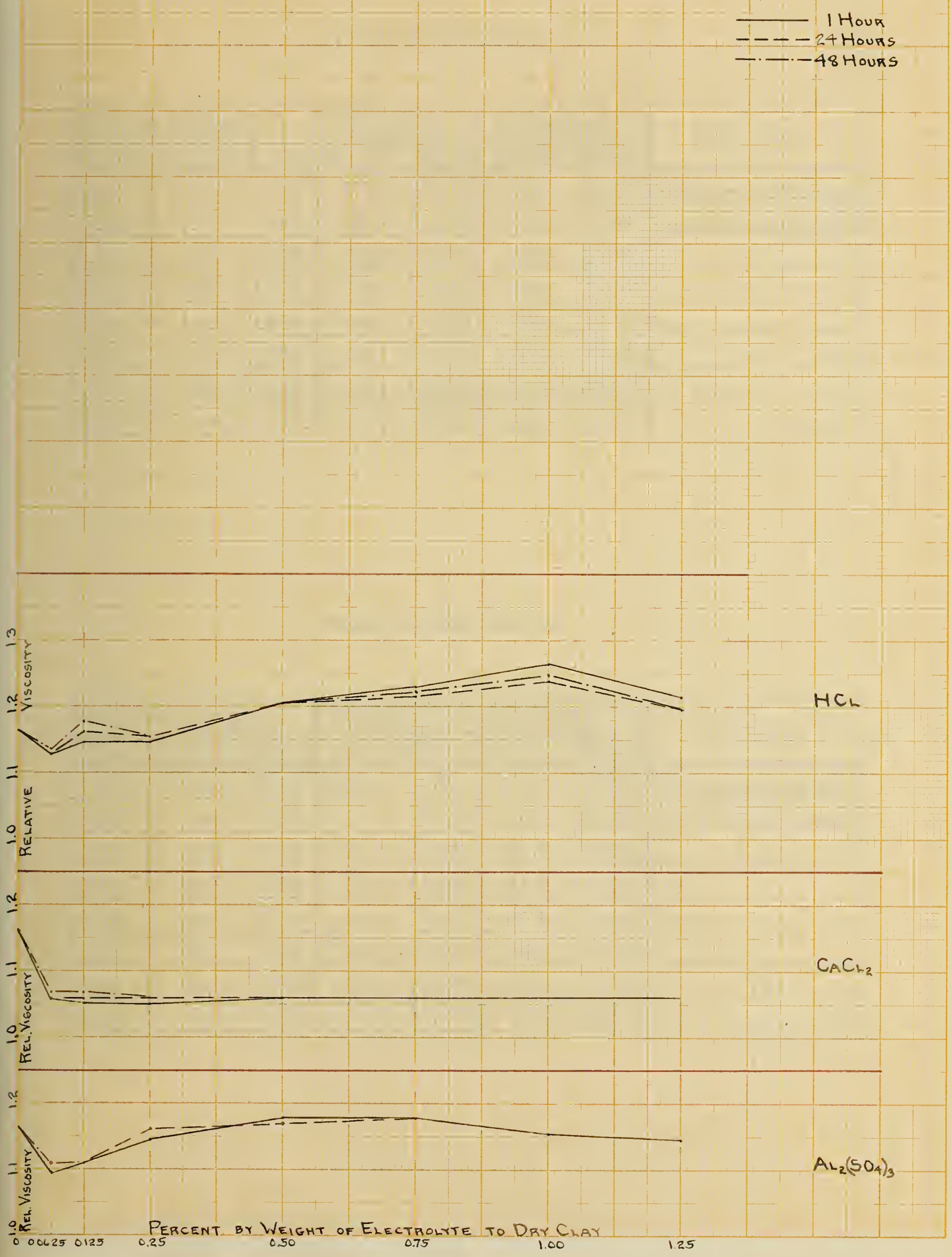


PLATE 6

CHANGE IN THE VISCOSITY OF FLORIDA KAOLIN SLIP WITH TIME



NaOH in N.C. Kaolin

% by Weight of NaOH in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% Clay
0.0625	38.6	1.649	38.6	1.649	38.4	1.641	Time of Flow of Water = 23.4 Seconds
0.125	30.0	1.282	30.0	1.282	29.8	1.274	
0.25	25.0	1.068	25.0	1.068	25.0	1.068	
0.50	24.8	1.059	24.8	1.059	24.4	1.043	
0.75	25.2	1.077	25.2	1.077	25.0	1.068	
1.00	26.4	1.128	26.4	1.128	26.0	1.111	
1.25	26.4	1.128	26.6	1.136	26.2	1.119	

NaCl in N.C. Kaolin

% by Weight of NaCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% Clay
0.0625	26.4	1.128	26.2	1.119	26.2	1.119	Time of Flow of Water = 23.4 Sec.
0.125	27.6	1.179	26.2	1.119	26.2	1.119	
0.25	27.8	1.188	26.2	1.119	26.2	1.119	
0.50	29.4	1.256	27.4	1.171	27.2	1.162	
0.75	30.0	1.282	26.8	1.145	26.6	1.136	
1.00	30.4	1.299	26.8	1.145	26.6	1.136	
1.25	30.0	1.282	26.8	1.145	26.8	1.145	

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$MgSO_4$ in N. C. Kaolin

% by Weight of $MgSO_4$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	34.4	1.470	35.0	1.495	35.2	1.504	Time of Flow of Water=23.4 Sec
0.125	33.2	1.419	34.2	1.461	34.2	1.461	
0.25	32.8	1.402	33.2	1.419	33.2	1.419	
0.50	31.8	1.359	32.8	1.402	32.8	1.402	
0.75	31.0	1.325	32.2	1.376	32.4	1.384	
1.00	30.6	1.308	31.2	1.333	31.4	1.342	
1.25	30.6	1.308	31.0	1.325	31.2	1.333	

$AlCl_3$ in N. C. Kaolin

% by Weight of $AlCl_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	31.4	1.342	33.6	1.436	33.8	1.444	Time of Flow of Water=23.4 Sec
0.125	33.2	1.419	34.8	1.487	35.0	1.495	
0.25	32.2	1.376	33.6	1.436	33.6	1.436	
0.50	33.4	1.427	34.8	1.487	34.8	1.487	
0.75	33.6	1.436	34.8	1.487	34.6	1.479	
1.00	34.4	1.470	35.4	1.513	35.4	1.513	
1.25	34.0	1.453	34.8	1.487	34.8	1.487	

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Na_2CO_3 in N.C. Kaolin

% by Weight of Na_2CO_3 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	29.2	1.248	28.8	1.231	28.8	1.231	Time of Flow of Water=23.4 Sec.
0.125	29.4	1.256	28.6	1.222	28.6	1.222	
0.25	28.8	1.231	28.6	1.222	28.6	1.222	
0.50	28.0	1.196	27.8	1.188	27.8	1.188	
0.75	26.8	1.145	26.8	1.145	26.8	1.145	
1.00	26.2	1.119	26.2	1.119	26.2	1.119	
1.25	26.0	1.111	26.0	1.111	26.0	1.111	

Na_2SO_4 in N.C. Kaolin

% by Weight of Na_2SO_4 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	38.8	1.658	38.6	1.649	38.6	1.649	Time of Flow of Water=23.4 Sec.
0.125	38.4	1.641	38.2	1.632	38.2	1.632	
0.25	36.6	1.564	36.6	1.564	36.6	1.564	
0.50	33.6	1.436	33.4	1.427	33.4	1.427	
0.75	33.4	1.427	33.4	1.427	33.4	1.427	
1.00	32.6	1.393	32.6	1.393	32.4	1.385	
1.25	31.4	1.342	31.4	1.342	31.4	1.342	

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$Al_2(SO_4)_3$ in N. C. Kaolin

% by Weight of $Al_2(SO_4)_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	38.4	1.641	38.6	1.649	38.8	1.658	Time of Flow of Water = 23.4 Sec
0.125	38.4	1.641	38.6	1.649	38.8	1.658	
0.25	39.0	1.666	39.4	1.684	39.4	1.684	
0.50	40.4	1.726	40.8	1.743	40.8	1.743	
0.75	40.2	1.718	41.0	1.751	41.2	1.759	
1.00	39.2	1.674	41.4	1.769	41.8	1.786	
1.25	40.4	1.726	41.2	1.759	41.6	1.777	

$CaCl_2$ in N. C. Kaolin

% by Weight of $CaCl_2$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	Slip Contained 31.75% clay
0.0625	36.0	1.538	37.6	1.607	37.6	1.607	Time of Flow of Water = 23.4 Sec
0.125	35.8	1.529	37.4	1.598	37.4	1.598	
0.25	35.8	1.529	37.2	1.589	37.4	1.598	
0.50	34.4	1.470	35.0	1.496	35.0	1.496	
0.75	33.6	1.436	34.2	1.461	34.4	1.470	
1.00	33.4	1.427	33.6	1.436	33.8	1.444	
1.25	32.6	1.393	32.6	1.393	32.6	1.393	

HCL IN N. C. KAOLIN

% BY WEIGHT OF HCL IN TERMS OF DRY CLAY	AFTER 1 HOUR SHAKING		AFTER 24 HOURS STANDING		AFTER 48 HOURS STANDING		REMARKS
	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	
0.00	27.6	1.179	27.6	1.179	27.6	1.179	SLIP CONTAINED 31.75% CLAY
0.0625	41.8	1.786	43.8	1.872	44.8	1.914	TIME OF FLOW OF WATER - 23.4 SEC
0.125	46.2	1.974	47.6	2.034	47.8	2.043	
0.25	49.6	2.119	48.6	2.077	48.8	2.086	
0.50	47.4	2.026	44.0	1.880	44.2	1.889	
0.75	46.0	1.965	43.6	1.863	43.6	1.863	
1.00	42.0	1.795	41.6	1.777	41.6	1.777	
1.25	42.0	1.795	40.2	1.718	40.2	1.718	

PLATE 7

CHANGE IN THE VISCOSITY OF NORTH CAROLINA KAOLIN SLIP WITH TIME

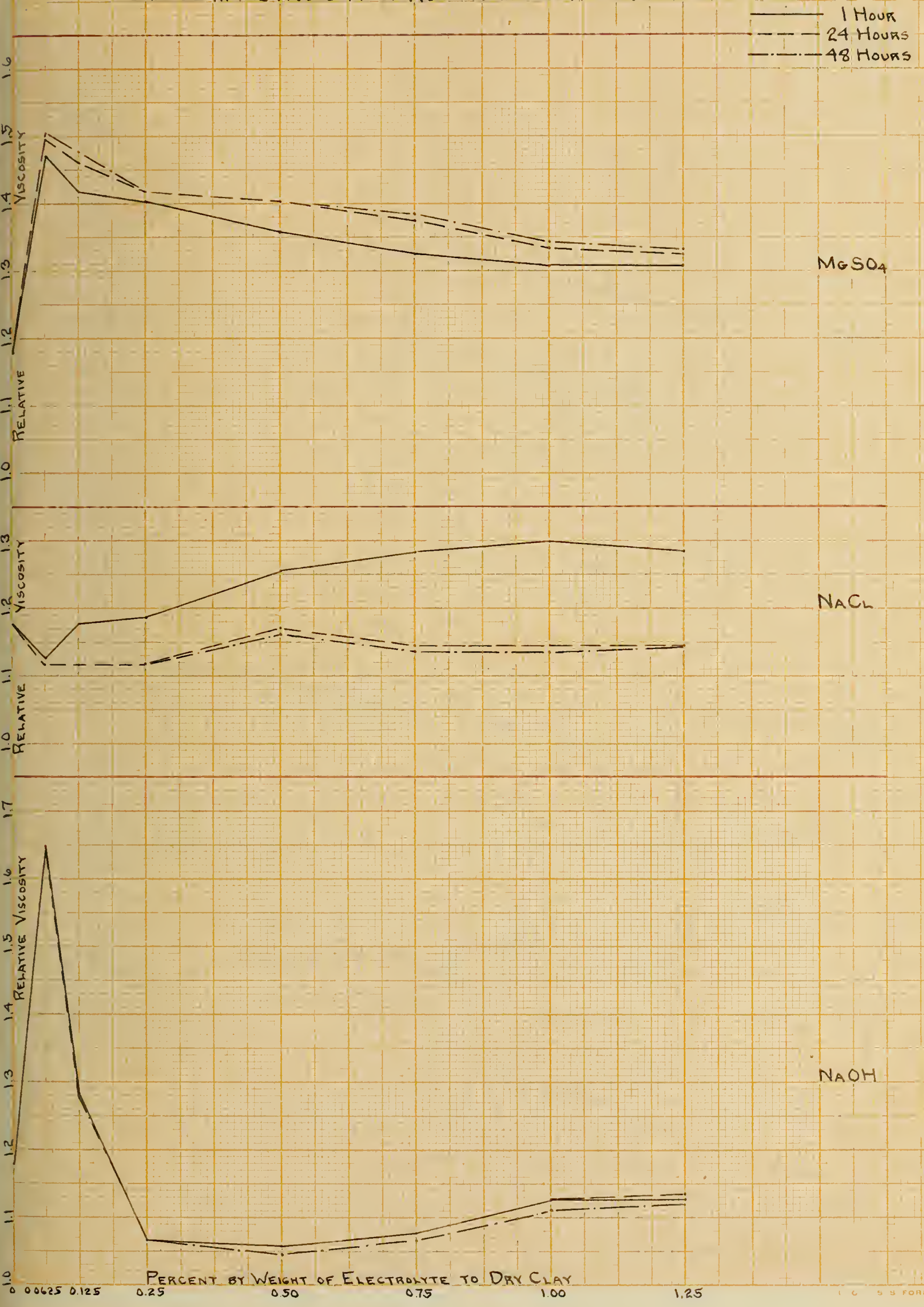


Plate 8

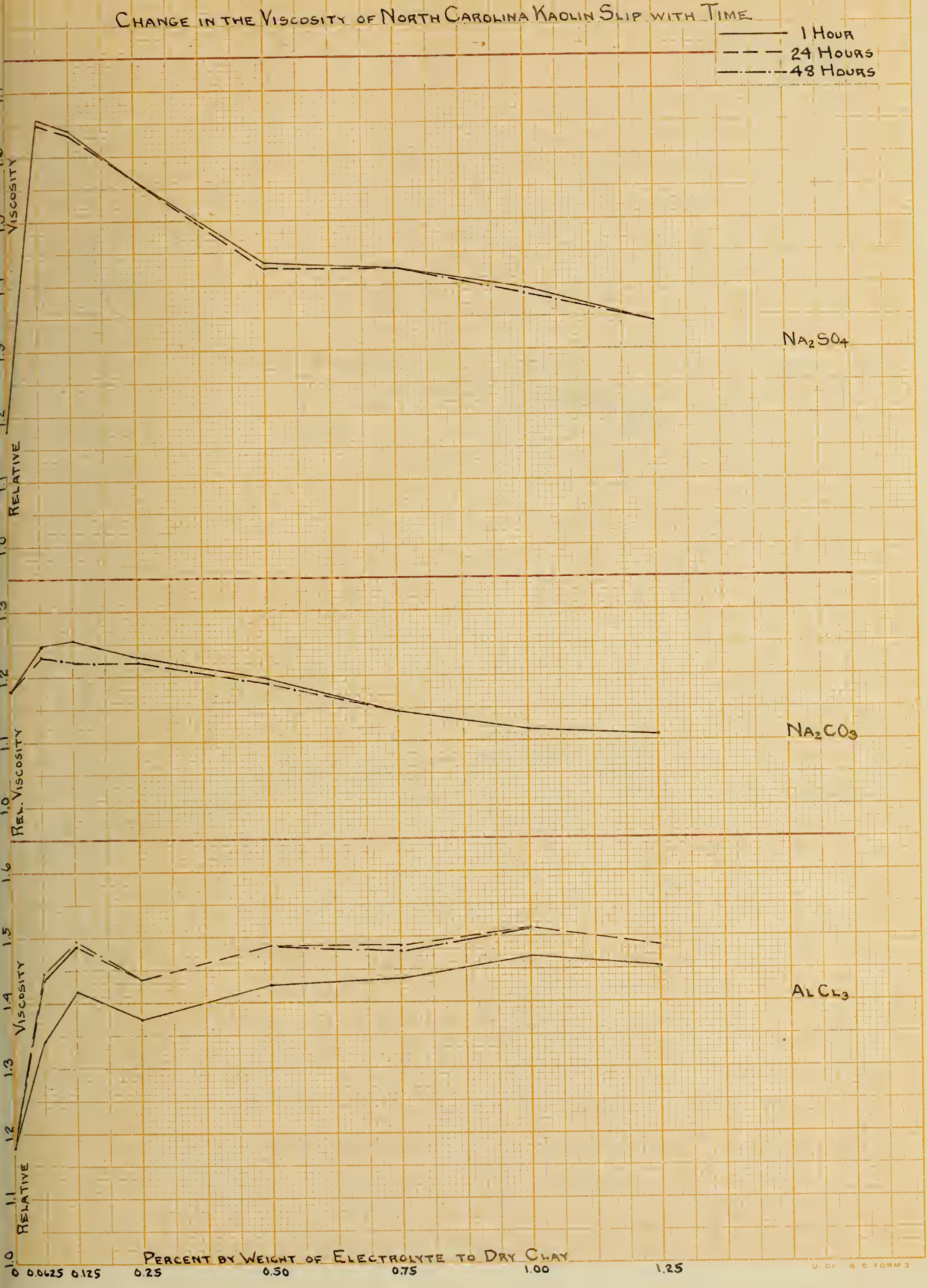

Change in the Viscosity of North Carolina Kaolin Slip with Time
1 Hour
24 Hours
48 Hours
Relative Viscosity
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
Na_2SO_4
Rel. Viscosity
1.0
1.1
1.2
1.3
Na_2CO_3
Relative Viscosity
1.0
1.1
1.2
1.3
1.4
1.5
1.6
$AlCl_3$
Percent by Weight of Electrolyte to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

PLATE 9

CHANGE IN THE VISCOSITY OF NORTH CAROLINA KAOLIN SLIP WITH TIME

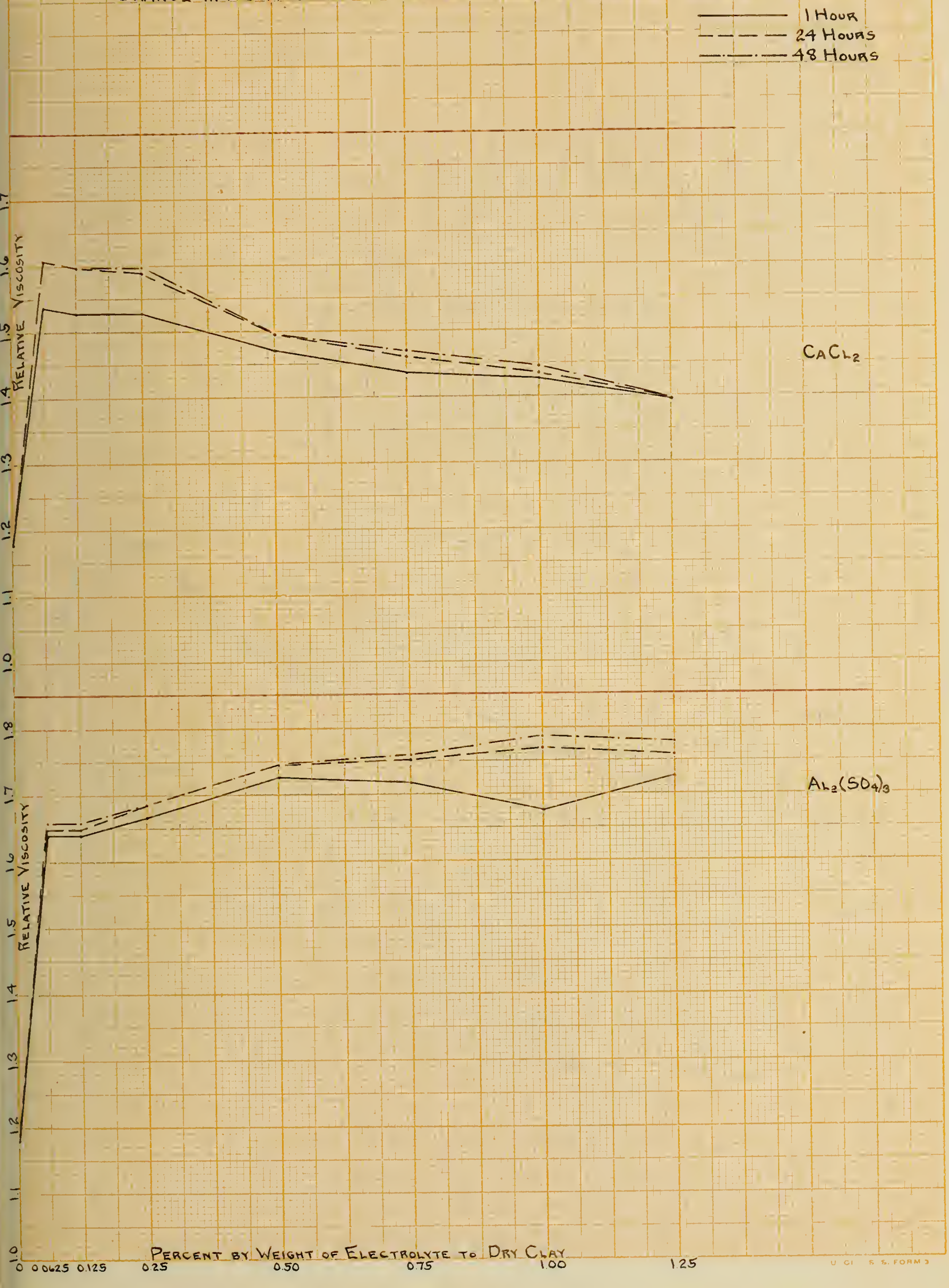
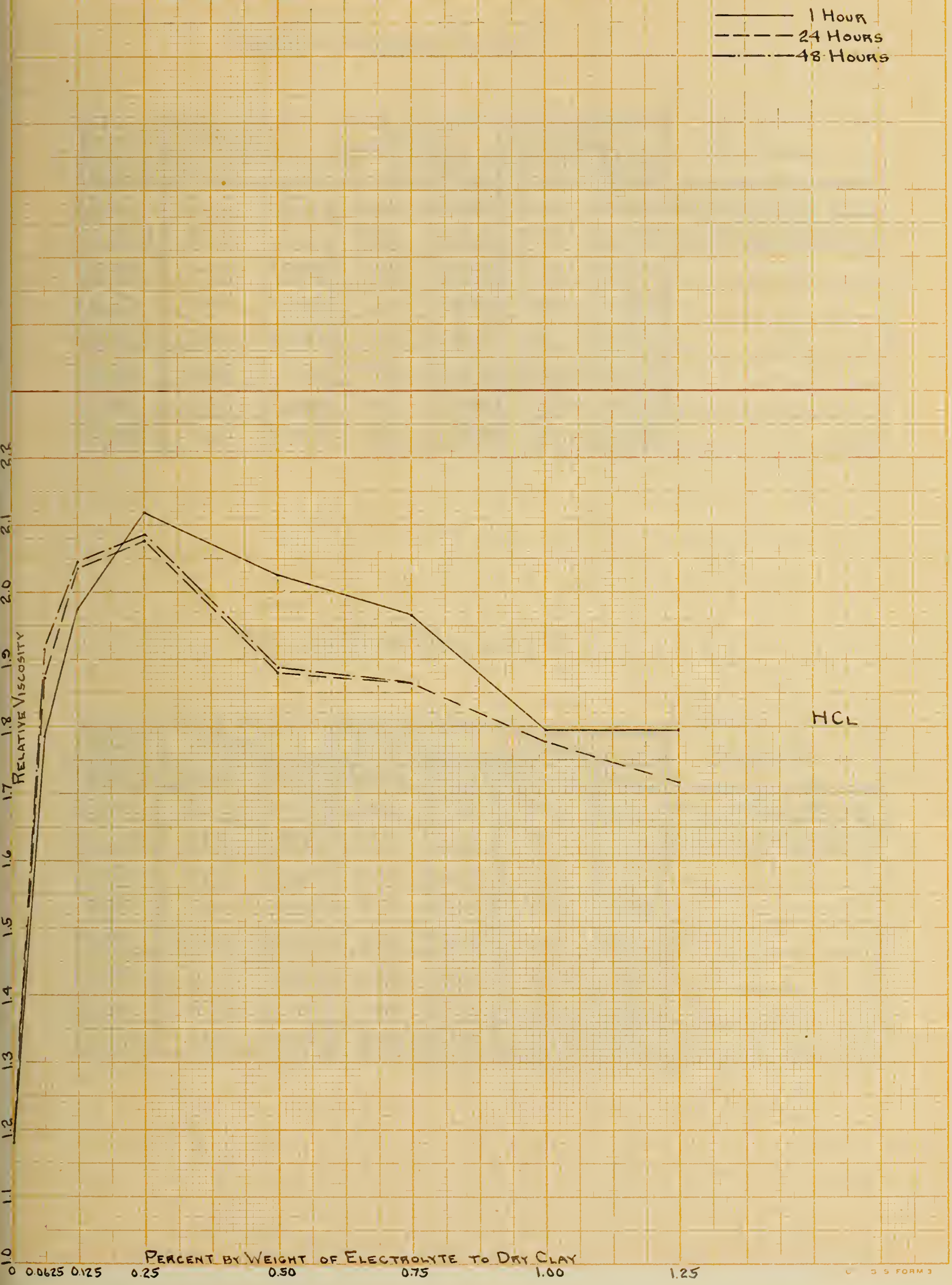


PLATE 10

CHANGE IN THE VISCOSITY OF NORTH CAROLINA KAOLIN SLIP WITH TIME



NaOH in Tenn. Ball Clay #1

% by Weight of NaOH in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip contained 25% Clay
0.0625	27.2	1.162	27.2	1.162	27.4	1.171	Time of Flow of Water = 23.4 Seconds
0.125	24.4	1.043	24.8	1.059	25.0	1.068	
0.25	24.4	1.043	24.4	1.043	24.4	1.043	
0.50	24.6	1.051	24.6	1.051	24.6	1.051	
0.75	25.8	1.103	25.8	1.103	25.6	1.094	
1.00	28.2	1.205	26.6	1.136	25.6	1.094	
1.25	30.6	1.308	28.2	1.205	27.0	1.153	

NaCl in Tenn. Ball Clay #1

% by Weight of NaCl in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip contained 25% clay
0.0625	27.2	1.162	27.2	1.162	27.2	1.162	Time of Flow of Water = 23.4 Sec.
0.125	27.2	1.162	27.2	1.162	27.2	1.162	
0.25	27.2	1.162	27.0	1.153	27.0	1.153	
0.50	27.4	1.171	27.2	1.162	27.2	1.162	
0.75	27.4	1.171	27.2	1.162	27.2	1.162	
1.00	27.6	1.179	27.2	1.162	27.2	1.162	
1.25	27.6	1.179	27.4	1.171	27.4	1.171	

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$MgSO_4$ in Tenn. Ball Clay #1

% by Weight of $MgSO_4$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.0	1.153	26.8	1.145	26.8	1.145	Time of Flow of Water = 23.4 Sec.
0.125	27.4	1.171	27.2	1.162	27.2	1.162	
0.25	27.4	1.171	27.2	1.162	27.2	1.162	
0.50	27.6	1.179	27.4	1.171	27.4	1.171	
0.75	27.4	1.171	27.6	1.179	27.6	1.179	
1.00	26.8	1.145	27.2	1.162	27.4	1.171	
1.25	26.8	1.145	27.2	1.162	27.4	1.171	

$AlCl_3$ in Tenn. Ball Clay #1

% by Weight of $AlCl_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.2	1.162	27.4	1.171	27.4	1.171	Time of Flow of Water = 23.4 Sec.
0.125	27.2	1.162	27.4	1.171	27.4	1.171	
0.25	27.4	1.171	27.4	1.171	27.4	1.171	
0.50	27.4	1.171	27.4	1.171	27.6	1.179	
0.75	28.0	1.196	28.2	1.205	28.4	1.214	
1.00	28.6	1.222	28.8	1.231	28.8	1.231	
1.25	28.6	1.222	28.8	1.231	28.8	1.231	

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Na_2CO_3 in Tenn. Ball Clay #1

% by Weight of Na_2CO_3 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.6	1.179	27.6	1.179	27.8	1.188	Time of Flow of Water=23.4 Sec.
0.125	28.0	1.196	28.0	1.196	28.2	1.205	
0.25	29.0	1.239	29.0	1.239	29.0	1.239	
0.50	28.8	1.231	28.2	1.205	28.2	1.205	
0.75	29.8	1.273	27.4	1.171	26.8	1.145	
1.00	29.0	1.239	27.2	1.162	26.8	1.145	
1.25	28.0	1.196	27.8	1.188	27.4	1.171	

Na_2SO_4 in Tenn. Ball Clay #1

% by Weight of Na_2SO_4 in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.4	1.171	27.4	1.171	27.2	1.162	Time of Flow of Water=23.4 Sec.
0.125	27.4	1.171	27.4	1.171	27.2	1.162	
0.25	27.4	1.171	27.4	1.171	27.2	1.162	
0.50	27.6	1.179	27.6	1.179	27.4	1.171	
0.75	28.0	1.196	28.0	1.196	28.0	1.196	
1.00	28.4	1.213	28.6	1.222	28.6	1.222	
1.25	28.6	1.222	28.8	1.231	28.8	1.231	

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$Al_2(SO_4)_3$ in Tenn. Ball Clay #1

% by Weight of $Al_2(SO_4)_3$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.0	1.153	27.4	1.171	27.4	1.171	Time of Flow of Water = 23.4 Sec
0.125	27.0	1.153	27.4	1.171	27.4	1.171	
0.25	27.0	1.153	27.2	1.162	27.2	1.162	
0.50	28.0	1.196	28.2	1.205	28.2	1.205	
0.75	28.6	1.222	28.8	1.231	28.8	1.231	
1.00	29.4	1.256	29.4	1.256	29.4	1.256	
1.25	29.0	1.239	29.2	1.248	29.2	1.248	

$CaCl_2$ in Tenn. Ball Clay #1

% by Weight of $CaCl_2$ in Terms of Dry Clay	After 1 Hour Shaking		After 24 Hours Standing		After 48 Hours Standing		Remarks
	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	Time of Flow Seconds	Relative Viscosity	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	Slip Contained 25% clay
0.0625	27.2	1.162	27.4	1.171	27.4	1.171	Time of Flow of Water = 23.4 Sec
0.125	27.0	1.153	27.2	1.162	27.2	1.162	
0.25	26.8	1.145	27.0	1.153	27.0	1.153	
0.50	27.0	1.153	27.0	1.153	27.2	1.162	
0.75	27.0	1.153	27.0	1.153	27.2	1.162	
1.00	27.2	1.162	27.2	1.162	27.2	1.162	
1.25	27.2	1.162	27.2	1.162	27.2	1.162	

HCL IN TENN. BALL CLAY #1

% BY WEIGHT OF HCL IN TERMS OF DRY CLAY	AFTER 1 HOUR SHAKING		AFTER 24 HOURS STANDING		AFTER 48 HOURS STANDING		REMARKS
	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	TIME OF FLOW SECONDS	RELATIVE VISCOSITY	
0.00	26.6	1.136	26.6	1.136	26.6	1.136	SLIP CONTAINED 25% CLAY
0.0625	27.6	1.179	27.8	1.188	27.8	1.188	TIME OF FLOW OF WATER = 23.4 SEC
0.125	28.0	1.196	28.2	1.205	28.4	1.214	
0.25	28.8	1.231	30.0	1.282	30.0	1.282	
0.50	30.0	1.282	31.0	1.325	31.2	1.333	
0.75	31.0	1.325	31.8	1.359	31.8	1.359	
1.00	32.0	1.367	33.0	1.423	33.2	1.419	
1.25	33.2	1.419	34.8	1.487	34.8	1.487	

PLATE 11

CHANGE IN VISCOSITY OF TENN BALL CLAY #1 SLIP WITH TIME

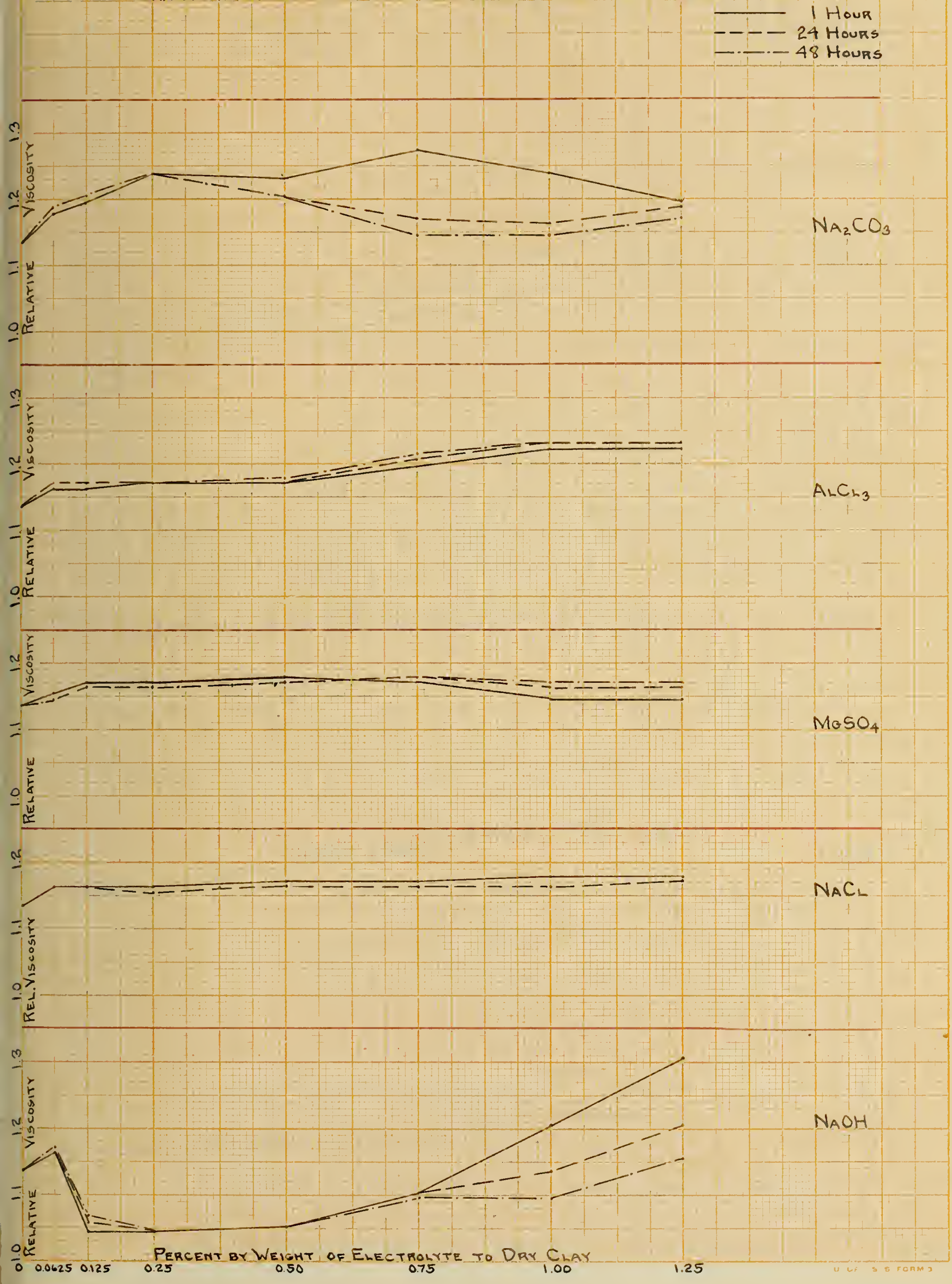
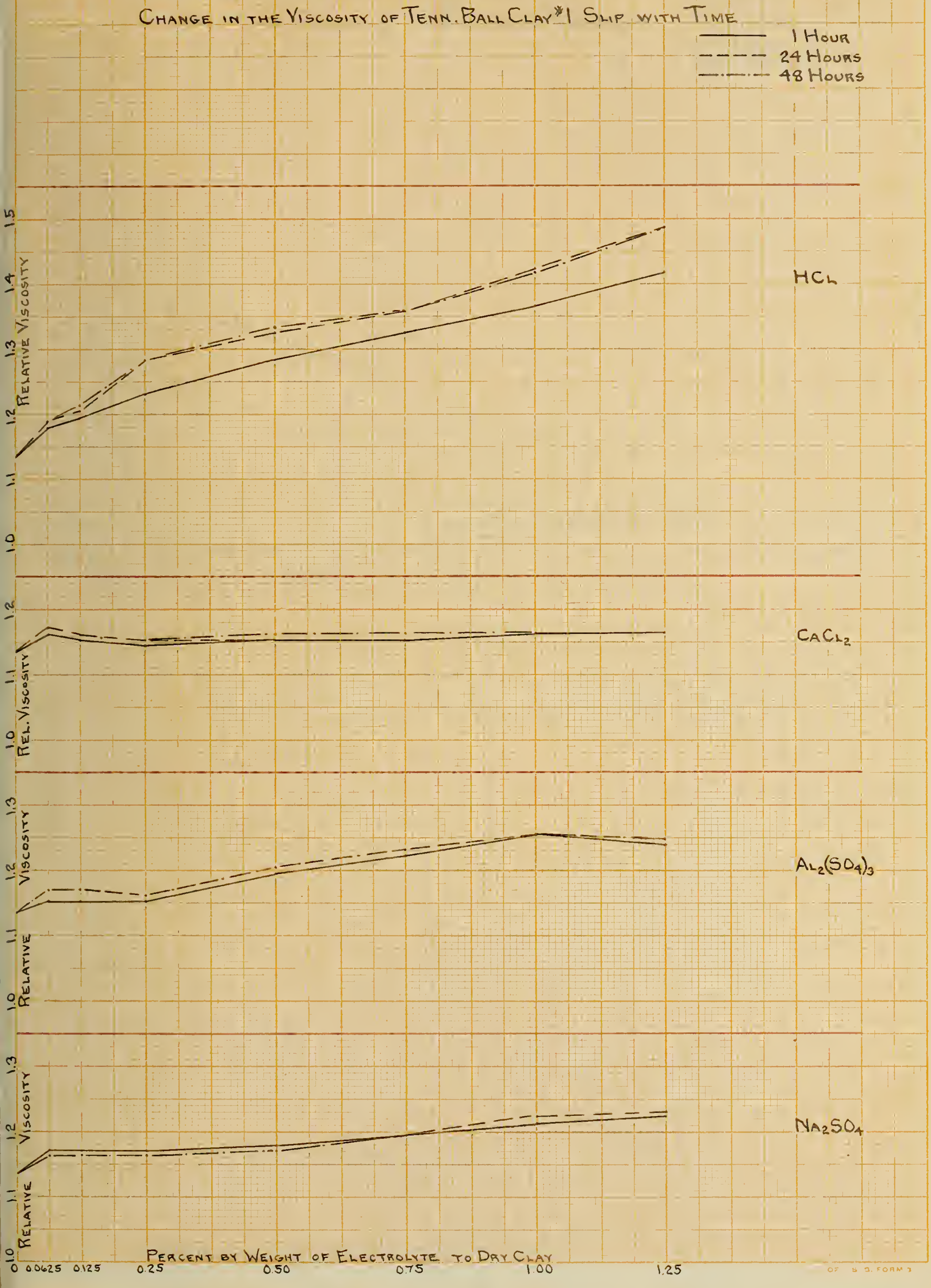


PLATE 12


CHANGE IN THE VISCOSITY OF TENN. BALL CLAY #1 SLIP WITH TIME
1 HOUR
24 HOURS
48 HOURS
RELATIVE VISCOSITY
1.0
1.1
1.2
1.3
1.4
1.5
HCL
REL. VISCOSITY
1.0
1.1
1.2
CACL2
RELATIVE VISCOSITY
1.0
1.1
1.2
1.3
AL2(SO4)3
RELATIVE VISCOSITY
1.0
1.1
1.2
1.3
NA2SO4
PERCENT BY WEIGHT OF ELECTROLYTE TO DRY CLAY
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

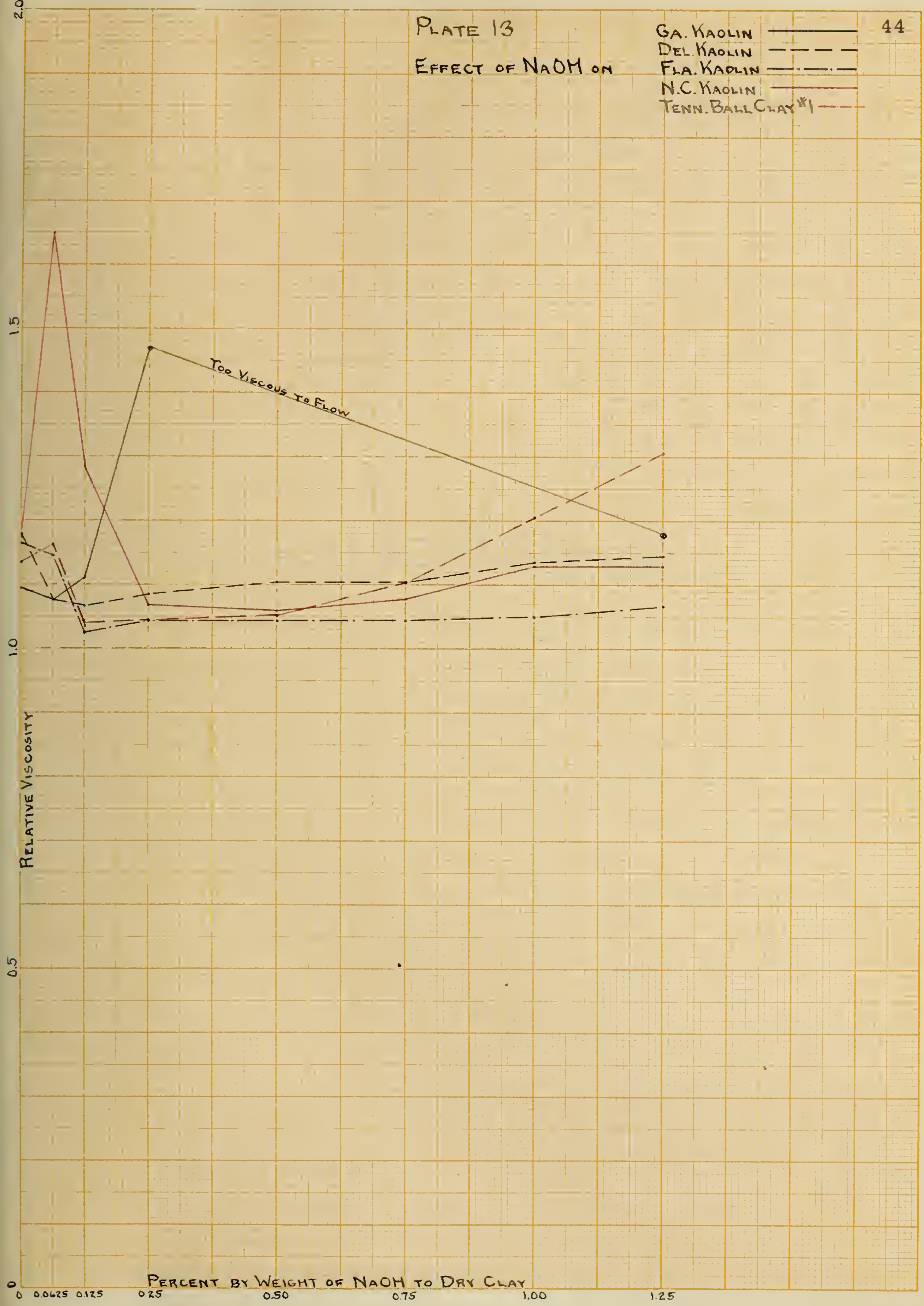


Plate 13
Effect of NaOH on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
Too Viscous to Flow
Relative Viscosity
Percent by Weight of NaOH to Dry Clay
0
0.5
1.0
1.5
2.0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

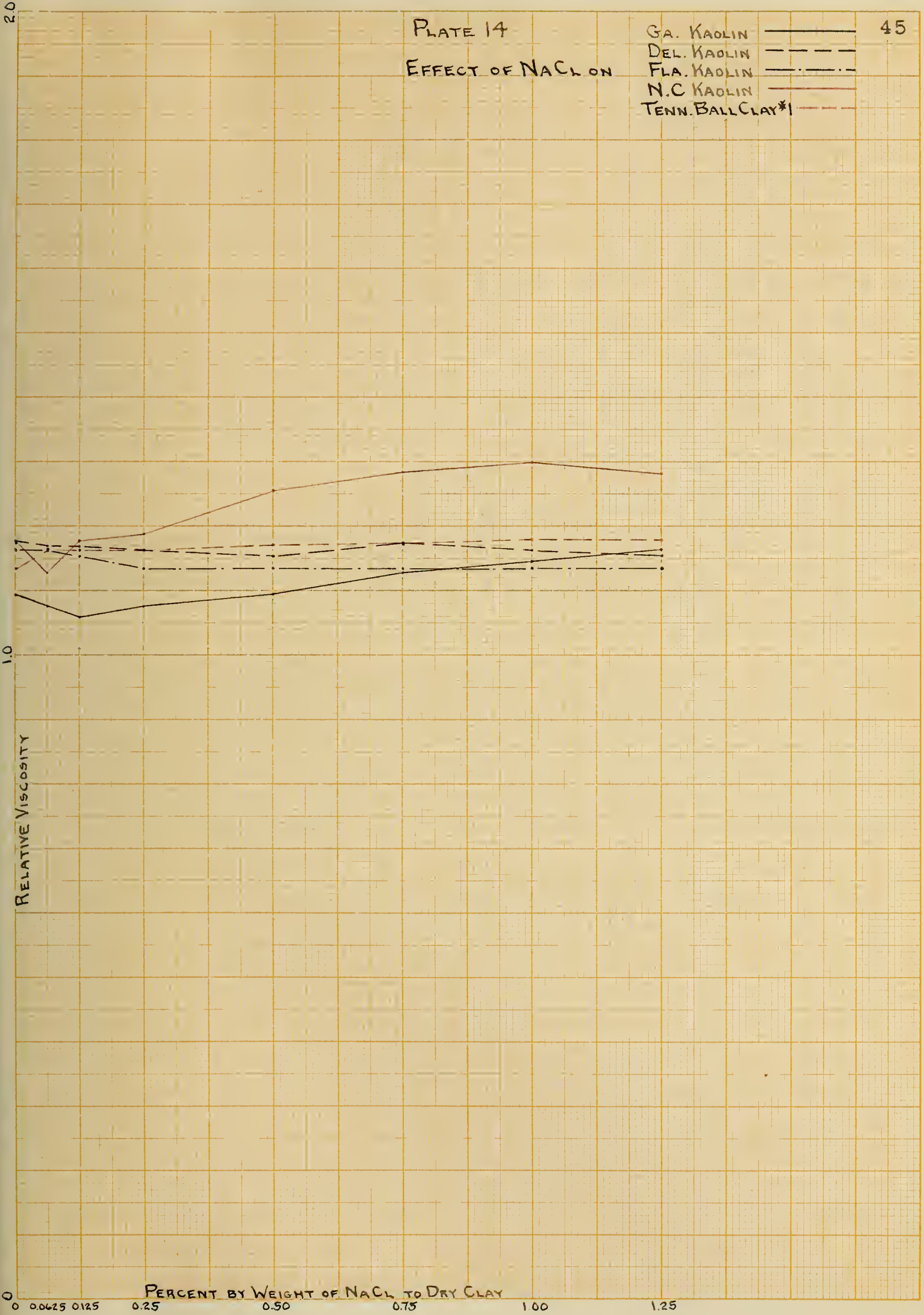


Plate 14
Effect of NaCl on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C Kaolin
Tenn. Ball Clay *1
Relative Viscosity
2.0
1.0
0
Percent by Weight of NaCl to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

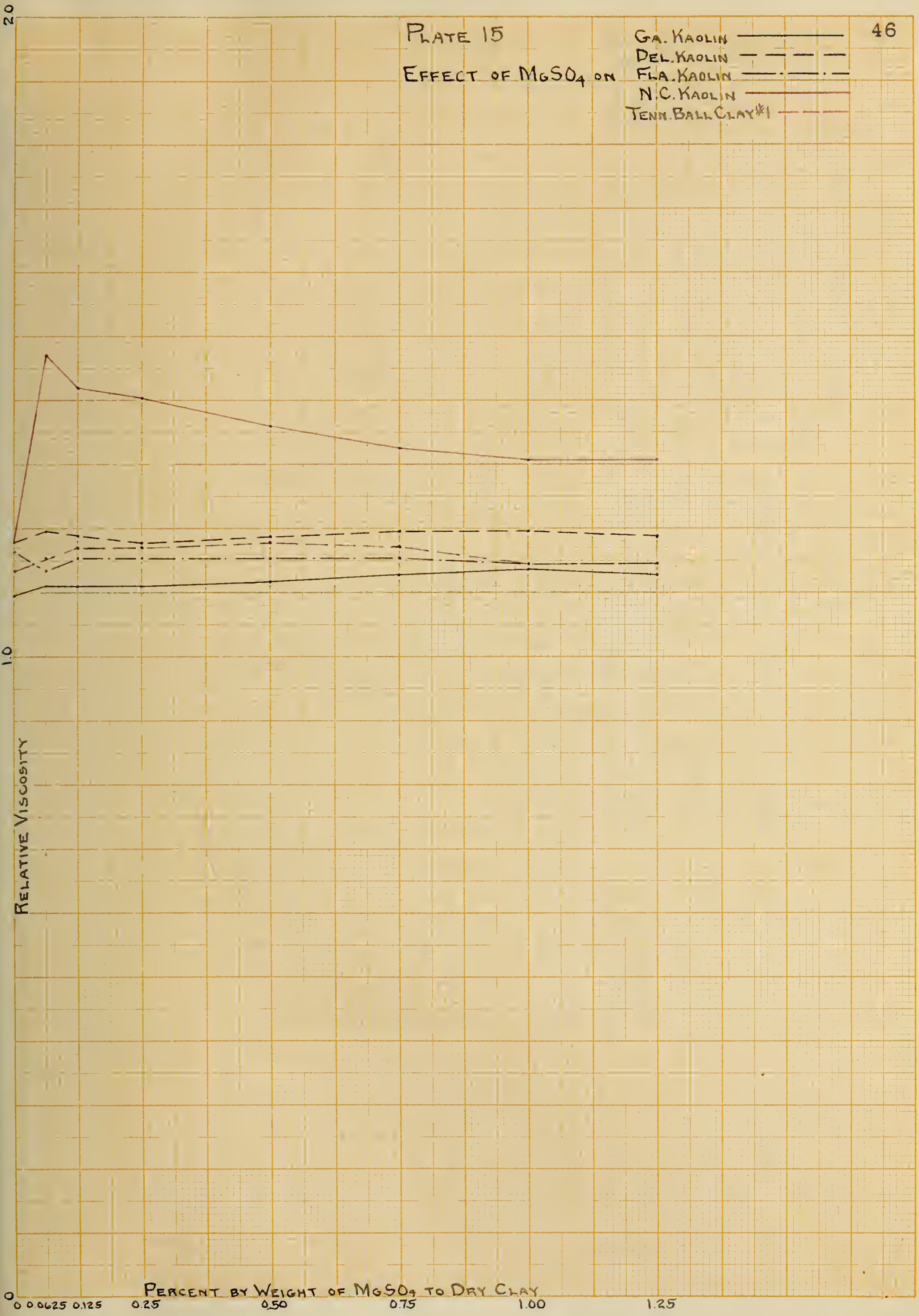


Plate 15
Effect of MgSO4 on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
2.0
1.0
0
Relative Viscosity
Percent by Weight of MgSO4 to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

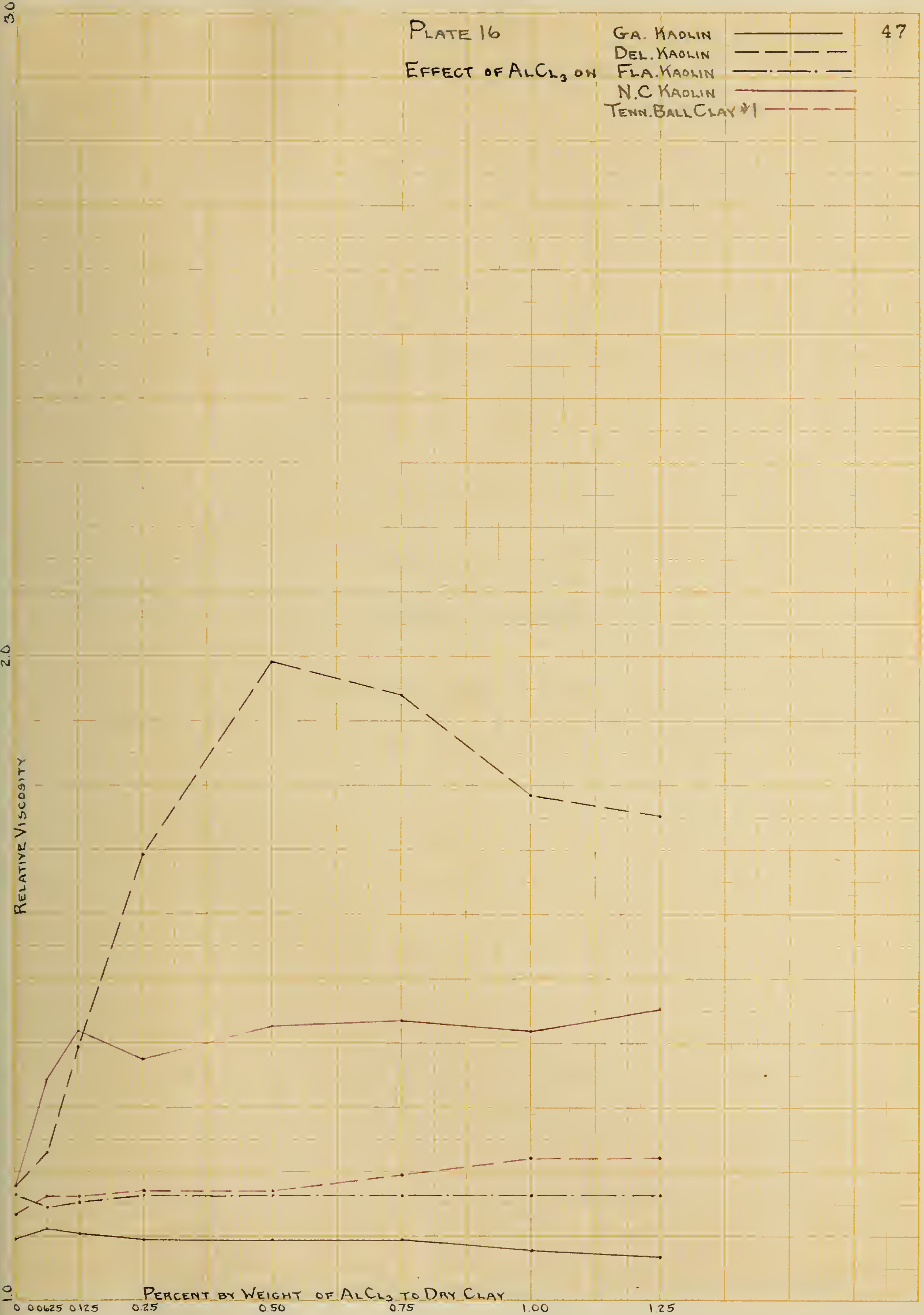


Plate 16
Effect of AlCl3 on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C Kaolin
Tenn. Ball Clay #1
Relative Viscosity
3.0
2.0
1.0
Percent by Weight of AlCl3 to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

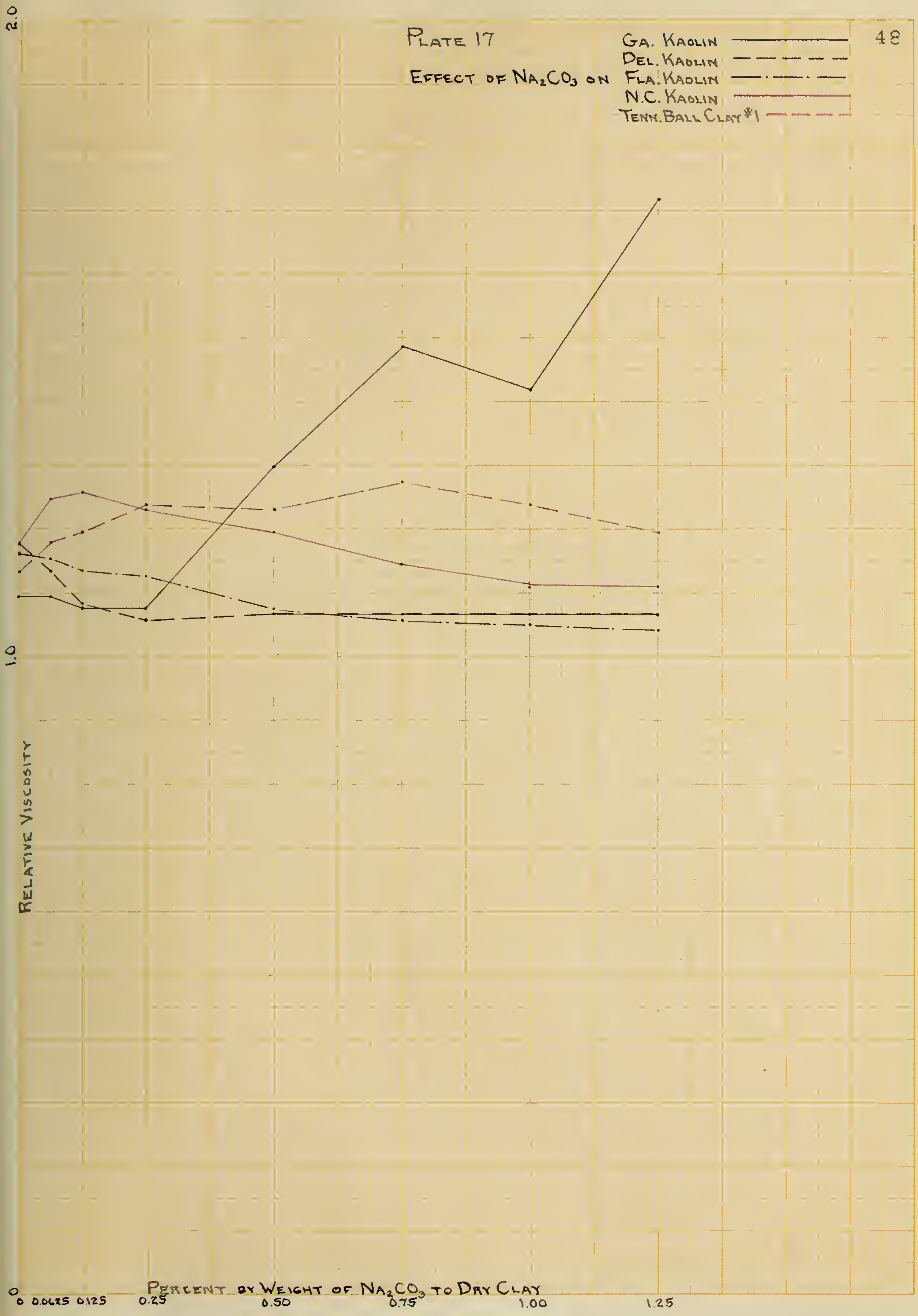


Plate 17
Effect of Na_2CO_3 on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
2.0
1.0
0
Relative Viscosity
Percent by Weight of Na_2CO_3 to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

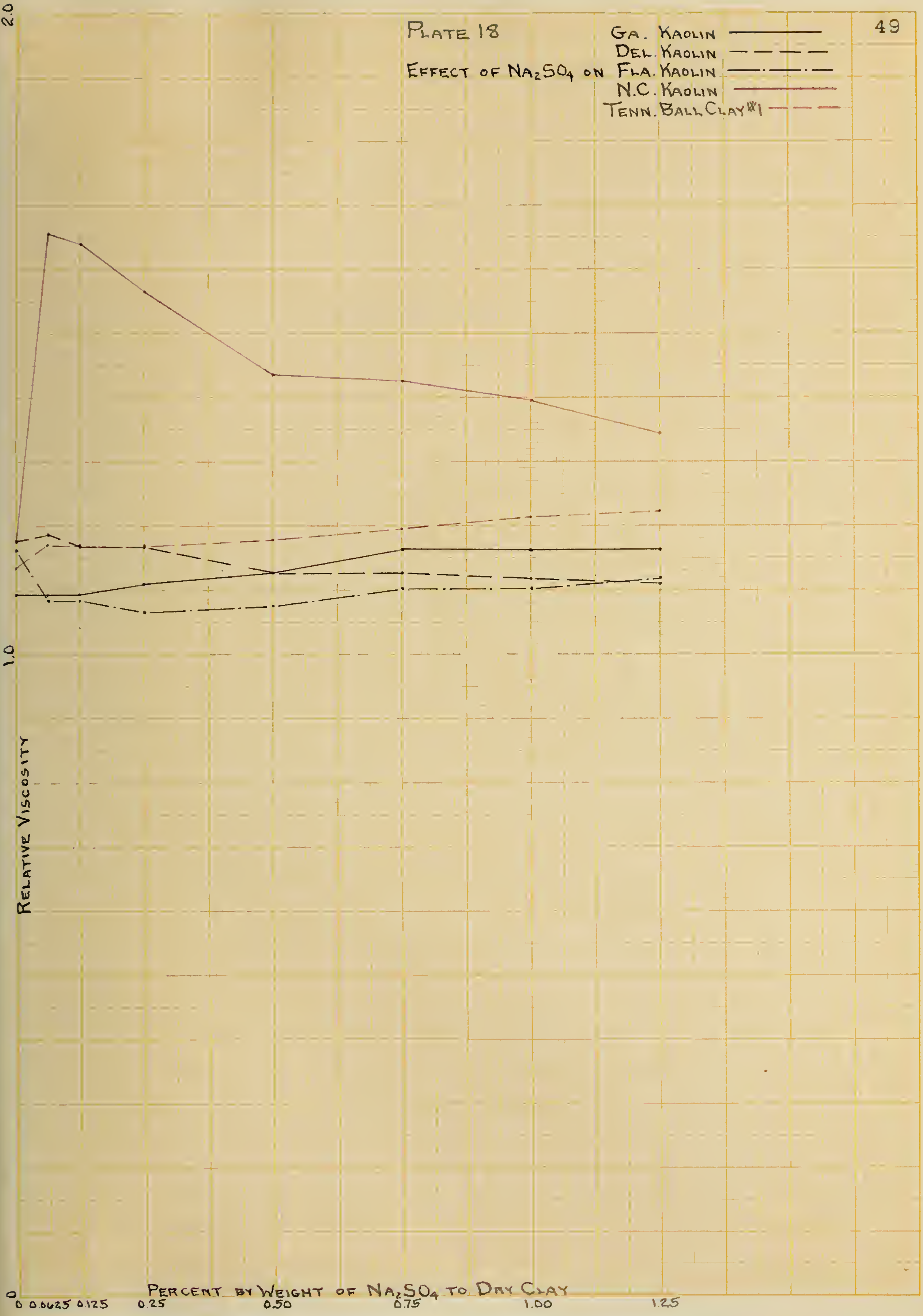


Plate 18
Effect of Na_2SO_4 on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
2.0
1.0
0
Relative Viscosity
Percent by Weight of Na_2SO_4 to Dry Clay
0 0.0625 0.125 0.25 0.50 0.75 1.00 1.25

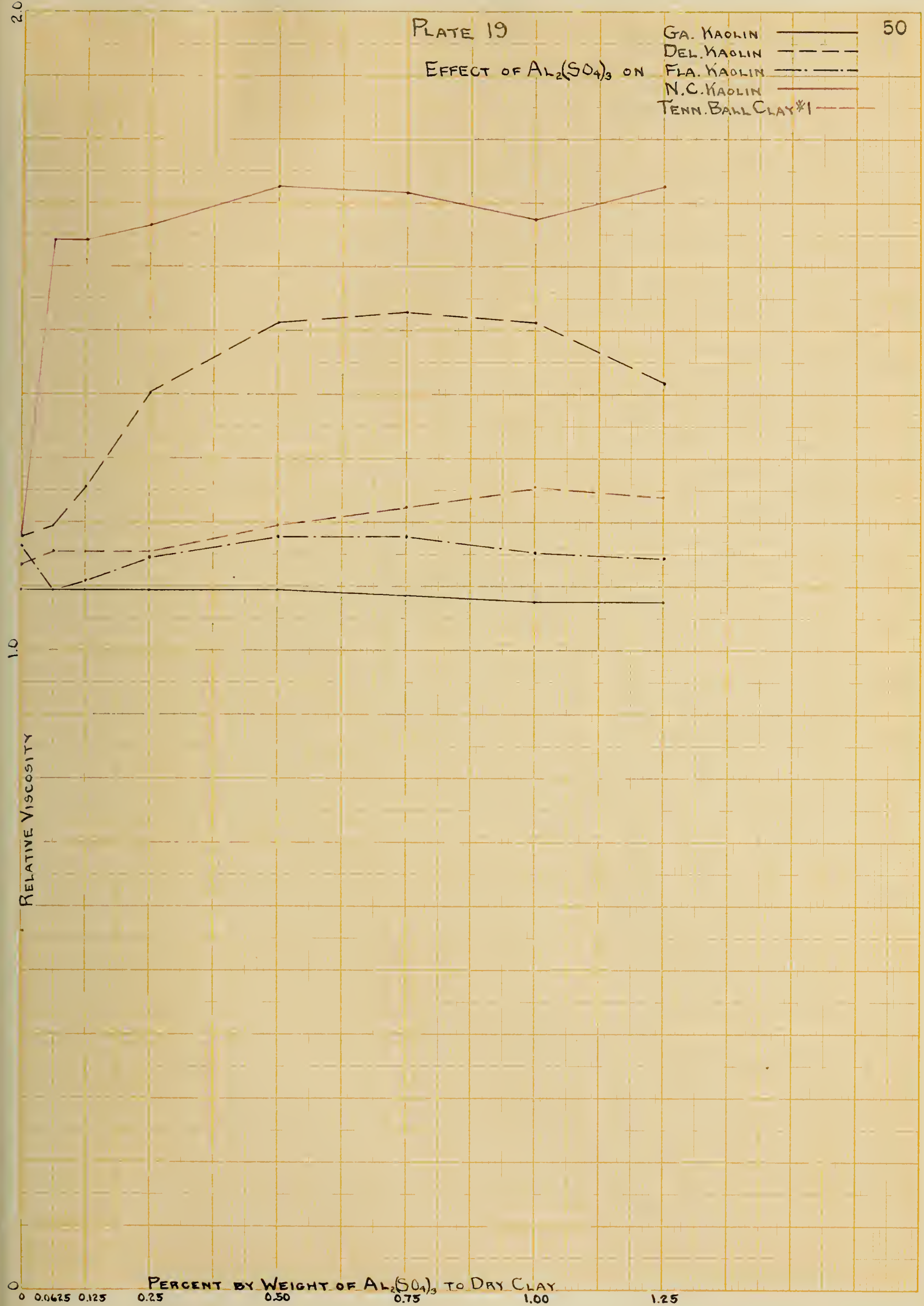


Plate 19
Effect of $Al_2(SO_4)_3$ on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
2.0
1.0
0
Relative Viscosity
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25
Percent by Weight of $Al_2(SO_4)_3$ to Dry Clay

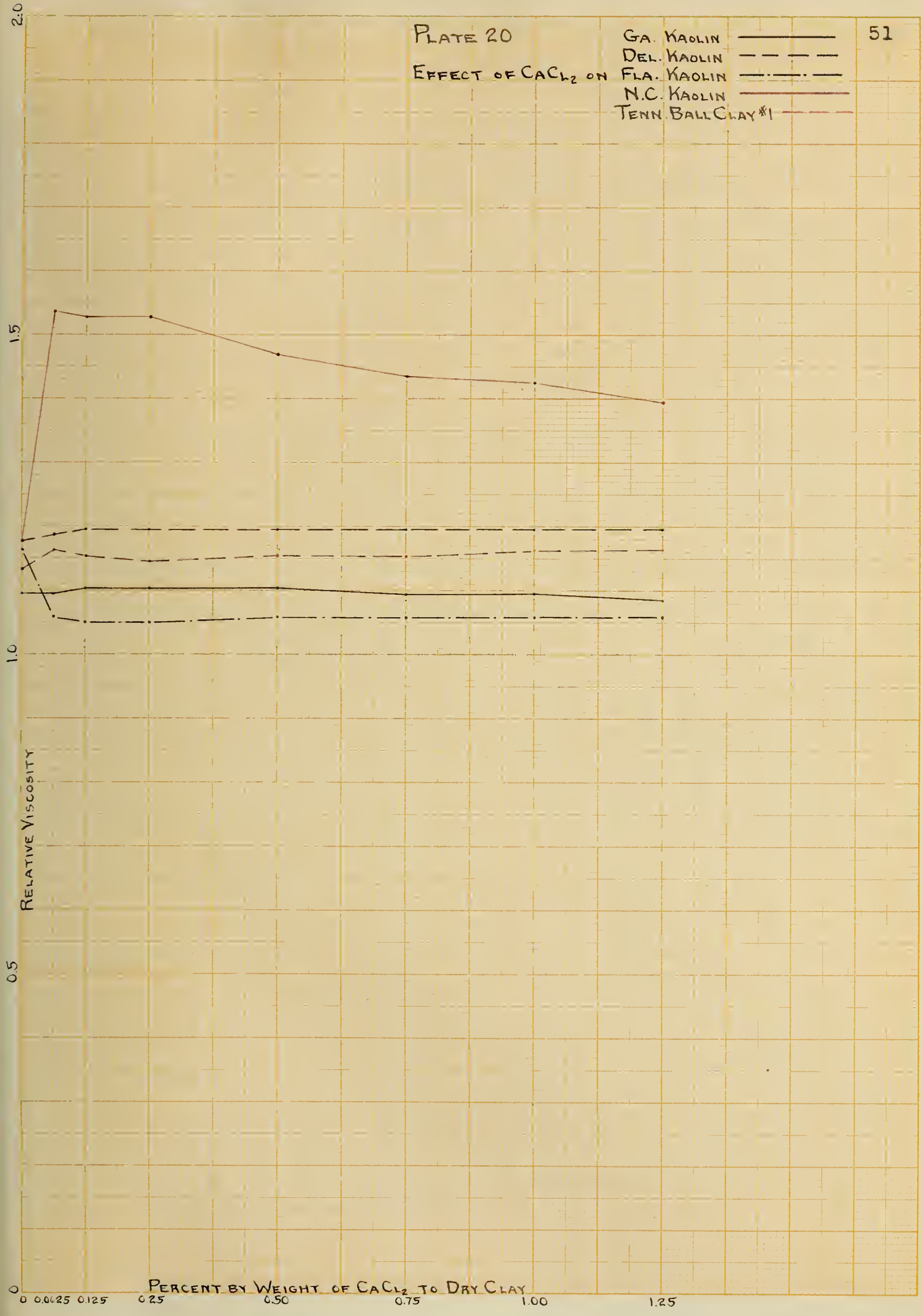


Plate 20
Effect of $CaCl_2$ on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
Relative Viscosity
2.0
1.5
1.0
0.5
0
Percent by Weight of $CaCl_2$ to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

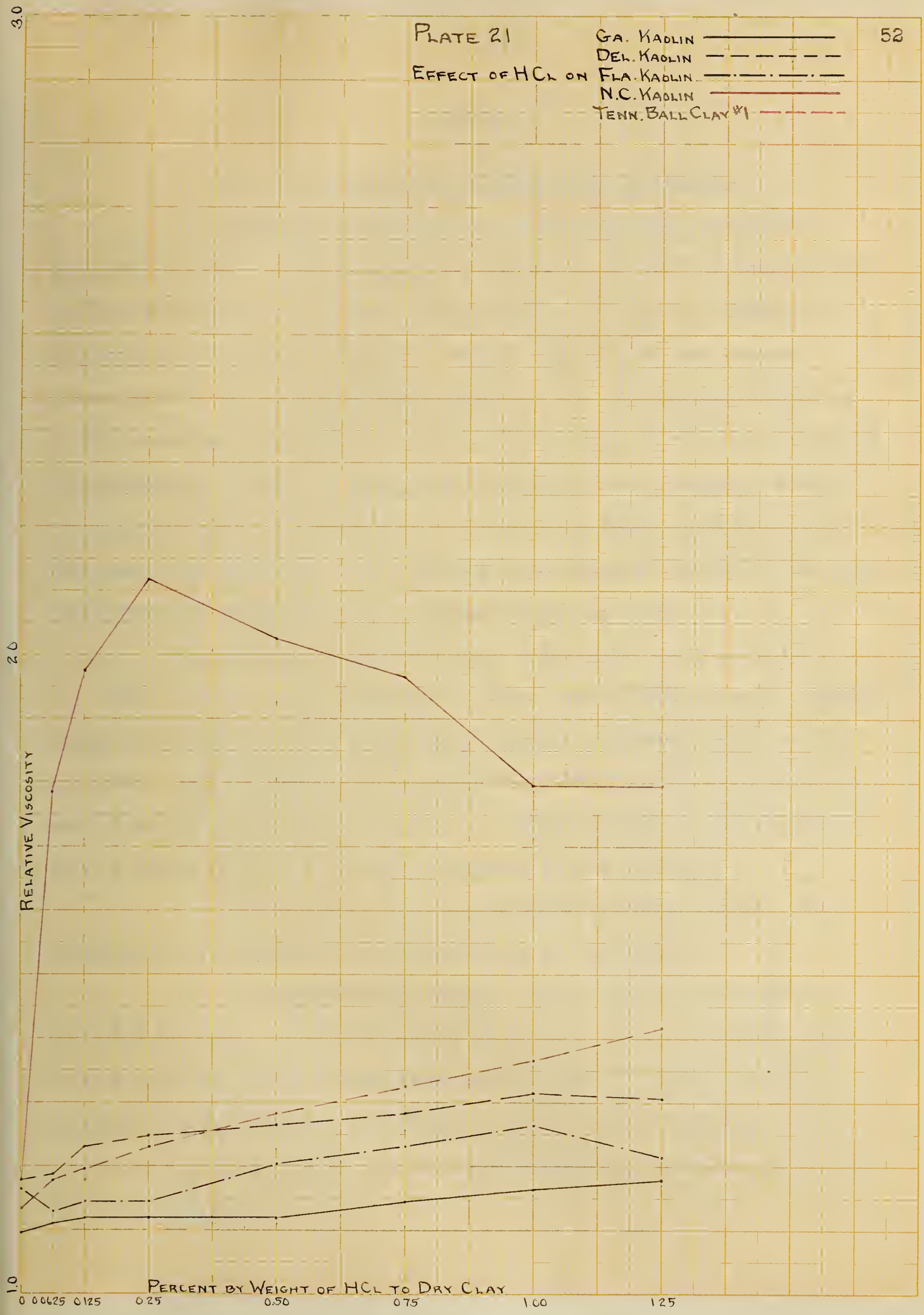


Plate 21
Effect of HCl on
Ga. Kaolin
Del. Kaolin
Fla. Kaolin
N.C. Kaolin
Tenn. Ball Clay #1
Relative Viscosity
3.0
2.0
1.0
Percent by Weight of HCl to Dry Clay
0
0.0625
0.125
0.25
0.50
0.75
1.00
1.25

RESULTS

I. The Effects of NaOH on the Viscosity.

1. Georgia Kaolin Slips. The slip used contained 33 1/3% of clay. The addition of less than 0.125% of NaOH caused deflocculation and decreased the viscosity slightly, reaching a minimum with 0.0625% of NaOH. Higher concentrations caused flocculation to a considerable extent, the addition of 0.25% to 1.00% causing the slips to become too viscous to flow through the viscosimeter. After standing for 24 hours the viscosity of all the slips decreased slightly, and after 48 hours another slight decrease was observed. The curves show Georgia kaolin to be very sensitive to changes in the concentration of NaOH.

2. Delaware Kaolin Slips. The slip used contained 33 1/3% of clay. The addition of less than 0.25% of NaOH caused slight deflocculation, reaching a minimum viscosity with 0.125% of NaOH. With higher concentrations of NaOH slight flocculation was observed, steadily increasing. After standing for 48 hours only a very slight decrease in viscosity was noticed.

The curves show that Delaware kaolin is not very sensitive to changes in the concentration of NaOH.

3. Florida Kaolin Slips. The slip used contained 26 2/3% of clay. The NaOH acted as a fair deflocculating agent. The viscosity reached a minimum with 0.125% of NaOH and then remained fairly constant; 24 hours standing had no effect on the viscosity of the slips, and 48 hours standing lowered the viscosity very slightly.

4. North Carolina Slips. The slip used contained 31 3/4% of clay. Low concentrations of NaOH caused flocculation to a considerable extent, reaching a maximum viscosity with 0.0625% of NaOH. Concentrations of NaOH above 0.25% caused slight deflocculation, reaching a minimum viscosity with 0.50% of NaOH. 24 and 48 hours standing had practically no effect on the viscosity of the slips.

5. Tennessee Ball Clay #1 Slips. The slip used contained 25% of clay. 0.0625% of NaOH caused some flocculation. Higher concentrations caused deflocculation, reaching a minimum viscosity with 0.125% of NaOH. 1.25% of NaOH caused slight flocculation to occur again. The effect of time was to increase the viscosity very slightly with low concentrations of NaOH and to decrease the viscosity very slightly with high concentrations.

II. The Effects of NaCl on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% of clay). The addition of NaCl up to 0.50% caused slight deflocculation, reaching a minimum viscosity with 0.125% of NaCl. Higher concentration caused slight flocculation. The effect of time was to increase the viscosity of the slips slightly.

2. Delaware Kaolin Slips (33 1/3% of clay). The addition of NaCl caused a very weak deflocculation in all cases, so weak as to be hardly noticeable. The effect of time was to decrease the viscosity very slightly.

3. Florida Kaolin Slips (26 2/3 % of clay). NaCl acted as a very weak deflocculating agent, reaching a minimum viscosity

with the addition of 0.25% to the clay. Concentrations above 0.25% gave the same viscosities. The effect of time was to slightly increase the viscosity of the slips high in NaCl, and slightly decrease the viscosity of slips low in NaCl.

4. North Carolina Kaolin Slips (31 3/4% of clay). 0.0625% NaCl caused deflocculation while higher concentrations produced some flocculation, reaching a maximum viscosity with 1.00% of NaCl. The effect of time was to cause deflocculation to a considerable extent.

5. Tennessee Ball Clay #1 Slips (25% of clay). NaCl acted as a very weak flocculating agent, all concentrations having the same effect. The effect of time is hardly noticeable, lowering the viscosity slightly.

III. The Effects of $MgSO_4$ on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% clay). $MgSO_4$ acted as a flocculating agent, 0.75% $MgSO_4$ causing the maximum amount of flocculation. With concentrations of $MgSO_4$ above 0.75% no increase in flocculation was observed. After 24 hours a very slight decrease in viscosity was observed. 48 hours standing again increased the viscosity.

2. Delaware Kaolin Slips (33 1/3% clay). The addition of $MgSO_4$ produced very little deflocculation, with very little variation at different concentrations. The effect of time was to decrease the viscosity slightly.

3. Florida Kaolin Slips (26 2/3% clay) $MgSO_4$ acted as a very weak deflocculating agent, reaching a minimum viscosity

with 0.0625% of $MgSO_4$. The effect of time was to increase the viscosity somewhat with high concentrations of the salt.

4. North Carolina Kaolin Slips (31 3/4% clay). $MgSO_4$ acted as a good flocculating agent. The curve shows a sudden increase to a maximum viscosity with 0.0625% of $MgSO_4$, then a decrease to constant flocculation with 1.00% of $MgSO_4$. The effect of time was to slightly increase the flocculation.

5. Tennessee Ball Clay #1 Slips (25% clay). $MgSO_4$ produced slight flocculation with concentrations of the salt up to 0.50%. The viscosity then gradually decreased to normal. The effect of time was to decrease the viscosity of slips containing low concentrations of $MgSO_4$ and to increase the viscosity of slips containing high concentration of $MgSO_4$. 48 hours had no further effect.

IV. The Effects of $AlCl_3$ on the Viscosity.

1. Georgia Kaolin Slips (33 1/3 of clay). Additions of $AlCl_3$ up to 0.125% caused slight flocculation, reaching maximum viscosity with 0.0625% of the salt. Higher Concentrations of $AlCl_3$ caused slight deflocculation. The effect time was practically negligible.

2. Delaware Kaolin Slips (33 1/3% clay). $AlCl_3$ acted as a very strong flocculating agent. The maximum flocculation was attained by the use of 0.50% of $AlCl_3$, higher percentages caused some decrease in the viscosity. After standing for 24 hours the viscosity of the slips were lowered in all cases. After standing for 48 hours the viscosity of the slips showed further

decrease in those containing less than 0.50% $AlCl_3$. An increase in viscosity was noted in those containing above 0.50% $AlCl_3$.

3. Florida Kaolin Slips (26 2/3% clay). $AlCl_3$ acted as a very weak deflocculating agent, the effect being hardly noticeable. Minimum viscosity was reached using 0.0625% of $AlCl_3$, maximum viscosity was reached using 0.25% of $AlCl_3$. The effect of time was very slight, the slips showing only a very slight decrease in viscosity after 48 hours standing.

4. North Carolina Kaolin Slips (31 3/4% clay). $AlCl_3$ acted as a good flocculating agent, but its action was not as strong as it was with Delaware Kaolin. The viscosity showed a rapid increase using concentrations of $AlCl_3$ up to 0.125%, higher concentration giving slight increases. The effect of time was to increase the viscosity of the slips slightly.

5. Tennessee Ball Clay #1 Slips (25% clay) $AlCl_3$, acted as a weak flocculating agent, but with increasing concentration of the salt a steady increase in viscosity was noticeable. The effect of time was to increase the viscosity very slightly.

V. The Effects of Na_2CO_3 on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% clay). The addition of Na_2CO_3 caused a slight deflocculation. Above 0.25% the salt acted as a flocculating agent to a considerable extent, the viscosity increasing with increase in the concentration of Na_2CO_3. The effect of time was to produce a slight increase in viscosity with low concentrations of Na_2CO_3, and a decrease in viscosity with higher concentrations of the salt.

2. Delaware Kaolin Slips (33 1/3 clay). Small additions of Na_2CO_3 caused some deflocculation, reaching a minimum viscosity with 0.25% of Na_2CO_3. With concentrations above 0.25% a slight increase in viscosity was noted. The effect of time was to lower the viscosity to a very slight extent.

3. Florida Kaolin Slips (26 2/3 clay). The addition of the salt caused deflocculation, the viscosity of the slips decreasing as the amount of Na_2CO_3 added increased. The effect of time was to lower the viscosity to a very slight extent.

4. North Carolina Kaolin Slips (31 3/4 clay). Na_2CO_3 acted as a flocculating agent in amount up to 0.50%, reaching a maximum viscosity with 0.125% of the salt. Higher concentrations of Na_2CO_3 caused deflocculation. The effect of time was to decrease the viscosity of the slips slightly.

5. Tennessee Ball Clay #1 Slips (25% clay) Na_2CO_3 acted as a good flocculating agent, giving a steady increase in viscosity with increase of the amount of salt added. Maximum viscosity was reached with 0.75% of Na_2CO_3. The effect of time was to decrease the viscosity with the higher percentages of Na_2CO_3.

VI. <u>The Effects of Na_2SO_4 on the Viscosity</u>.

1. Georgia Kaolin Slips (33 1/3% clay). Na_2SO_4 acted as a flocculating agent to some extent, reaching a maximum with 0.75% of the salt. The effect of time was to increase the viscosity of the slips to quite a marked extent.

2. Delaware Kaolin Slips (33 1/3% clay). Na_2SO_4 caused

some deflocculation, the viscosity of the slips decreasing with higher concentrations of the salt. The effect of time was to decrease the viscosity of slips containing less than 0.75% of Na_2SO_4.

3. Florida Kaolin Slips (26 2/3% clay). Na_2SO_4 acted as a deflocculating agent, the action being more noticeable than the action of Na_2SO_4 on the Delaware Kaolin. A minimum viscosity was reached with 0.25% of the salt. Time of standing had very little effect on the viscosity, the viscosities becoming slightly increased for the slips containing the larger amounts of the salt and slightly decreased for those containing smaller amounts.

4. North Carolina Kaolin Slips (31 3/4 clay). Na_2SO_4 caused considerable flocculation of the slips, reaching a maximum viscosity with 0.0625% of the salt, and then showing a decrease. Time of standing had practically no effect on the viscosity of the slips.

5. Tennessee Ball Clay #1 Slips (25% clay). Na_2SO_4 caused slight flocculation, the viscosity of the slips increasing with increasing concentrations of the salt. Time of standing had practically no effect on the viscosity of the slips.

VII. The Effects of $Al_2(SO_4)_3$ on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% clay). The addition of more than 0.50% of the salt caused a very slight deflocculation that was scarcely noticeable. After standing for 48 hours the viscosity showed a slight increase in all cases.

2. Delaware Kaolin Slips (33 1/3% clay). $Al_2(SO_4)_3$

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[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

acted as a good flocculating agent, the viscosity of the slips increasing with increasing amounts of the salt up to 0.75%. The effect of time was to decrease the viscosity of most of the slips, although a slight decrease in viscosity was noticeable in the slips containing above 0.75% of the salt.

3. Florida Kaolin Slips (26 2/3% clay). Additions of less than 0.25% of the salt caused deflocculation, the viscosity of the slips reaching a minimum viscosity with 0.0625% of $Al_2(SO_4)_3$. Higher concentrations of the salt had little effect on the slips. The effect of time was to slightly increase the viscosity of slips containing low concentrations of the salt.

4. North Carolina Kaolin Slips (31 3/4% clay). The viscosity of the slips was increased to a very marked extent with 0.0625% of the salt, the viscosity reaching a maximum viscosity with 0.50% $Al_2(SO_4)_3$. The effect of time was to increase the viscosity, the increase being more noticeable in the slips containing the higher concentrations of the salt.

5. Tennessee Ball Clay #1 Slips (25% clay). The addition of the salt caused some flocculation of the slips, the maximum viscosity being reached with 1.00% of $Al_2(SO_4)_3$. The effect of time upon the viscosity of the slips was scarcely noticeable, the increase being very slight.

VIII. The Effects of $CaCl_2$ on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% clay). The action of the salt was very weak, the concentrations up to 0.50% causing slight flocculation and above 0.50% slight deflocculation.

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The effect of time did not change the viscosity of the slips.

2. Delaware Kaolin Slips (33 1/3% clay). The action of the salt was very weak and only slightly flocculated the slips. Increasing concentrations had no effect towards further flocculation. The time of standing of the slips had practically no effect on the viscosity.

3. Florida Kaolin Slips (26 2/3% clay). $CaCl_2$ acted as a fairly strong deflocculating agent, the viscosity being very marked with 0.0625% of the salt and then remaining constant with higher concentrations. The time of standing had practically no effect on the viscosity of the slips.

4. North Carolina Kaolin Slips (31 3/4% clay). $CaCl_2$ acted as a rather strong deflocculating agent, the viscosity showing a marked increase in the slip containing 0.0625% of the salt. The effect of time was to increase the viscosity of the slips in all cases, especially so in those containing 0.125% and 0.25% $CaCl_2$.

5. Tennessee Ball Clay #1 Slips (25% clay) $CaCl_2$ acted as a weak deflocculating agent, the viscosity attaining a maximum with 0.0625% $CaCl_2$. Time of standing had practically no effect upon the viscosity of the slips.

IX. The Effects of HCl on the Viscosity.

1. Georgia Kaolin Slips (33 1/3% clay). HCl caused slight flocculation, the increase in viscosity of the slips becoming more marked with higher concentrations of the acid. The effect of time was to slightly increase the viscosity of the slips.

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[illegible]

[illegible]

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[illegible]

2. Delaware Kaolin Slips (33 1/3% clay). The action of HCl on the Delaware kaolin was more pronounced than on the Georgia kaolin, the flocculation being greater. After standing for 48 hours a slight decrease in viscosity was noticed in slips containing low concentrations of HCl, and a fair increase in viscosity in slips containing the higher concentrations of the acid.

3. Florida Kaolin Slips (26 2/3% clay) HCl acts as a deflocculating agent in amounts of less than 0.25%, minimum viscosity being reached using 0.0625% of HCl. In amounts of over 0.25%, the acid causes flocculation to some extent. The effect of time was to produce a marked decrease in the viscosity of slips containing high concentrations of HCl.

4. North Carolina Kaolin Slips (31 3/4% clay). HCl acted as a strong flocculating agent, the slips reaching maximum flocculation with 0.25% HCl and minimum with 1.00%. The effect of time was to produce a marked decrease in the viscosity of slips containing high concentrations of HCl.

5. Tennessee Ball Clay #1 Slips (25% clay). HCl acted as a fair flocculating agent, the viscosity of the slips increasing with increasing concentrations of the acid. The time of standing was to produce a marked increase in viscosity in all cases.

CONCLUSIONS AND SUMMARY

Low concentrations of NaOH cause fair deflocculation and higher concentrations cause marked flocculation of Georgia, Delaware, and Florida kaolins. Low concentrations of NaOH cause marked flocculation and higher concentrations cause some deflocculation of North Carolina kaolin and Tennessee Ball Clay #1.

Low concentrations of NaCl cause very slight deflocculation and higher concentrations cause very slight flocculation of Georgia kaolin. NaCl acts as a weak deflocculating agent on Delaware and Florida kaolins. Low concentrations of NaCl cause a fair amount of deflocculation and higher concentrations a fair amount of flocculation of North Carolina kaolin. NaCl acts as a very weak flocculating agent on Tennessee Ball Clay #1.

$MgSO_4$ acts as a fair flocculating agent on Georgia kaolin, as a very weak deflocculating agent on Delaware and Florida kaolins, as a strong flocculating agent on North Carolina kaolin, and as a weak flocculating agent on Tennessee Ball Clay #1.

$AlCl_3$ has little effect on Georgia kaolin, acts as a very weak deflocculating agent on Florida kaolin, and as a fair flocculating agent, if used in high enough concentrations, on Tennessee Ball Clay #1. $AlCl_3$ acts as a strong flocculating agent on North Carolina kaolin, and has a still stronger flocculating action on Delaware kaolin.

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Low concentrations of Na_2CO_3 cause slight deflocculation of Georgia and Delaware kaolins. Higher concentrations of Na_2CO_3 cause increasing flocculation to a marked extent on Georgia kaolin, and to only a slight extent on Delaware kaolin. Increasing concentrations of Na_2CO_3 cause increasing deflocculation of Florida kaolin and marked flocculation of Tennessee Ball Clay #1. Low concentrations of Na_2CO_3 cause fair flocculation and higher concentrations cause fair deflocculation of North Carolina kaolin.

Na_2SO_4 acts as a fair flocculating agent on Georgia kaolin, as a rather weak deflocculating agent on Delaware kaolin, as a slightly stronger deflocculating agent on Florida kaolin, as a good flocculating agent on North Carolina kaolin, and as a weak flocculating agent, flocculation increasing with higher concentrations of the salt, on Tennessee Ball Clay #1.

$Al_2(SO_4)_3$ acts as a very weak deflocculating agent on Georgia kaolin and as a slightly more powerful deflocculating agent on Florida kaolin. $Al_2(SO_4)_3$ acts as a fair flocculating agent on Tennessee Ball Clay #1, as a strong flocculating agent on Delaware kaolin, and as a still more powerful flocculating agent on North Carolina kaolin.

$CaCl_2$ has practically no effect on Georgia and Delaware kaolins. It exerts some deflocculating action on Florida and North Carolina kaolins, and acts as a very weak deflocculating agent on Tennessee Ball Clay #1. $CaCl_2$ is a very ineffective reagent in its action of flocculation or deflocculation.

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HCl acts as a fair flocculating agent on all the clays tested, its effect being more pronounced on the Delaware kaolin and Tennessee Ball Clay #1 than on the other clays.

In most cases the effect of time was to increase the effects of the lower concentrations of the electrolytes on the clay slips. These changes were noticeable after 24 hours, while 48 hours standing caused only very slight further effects.

North Carolina kaolin responds much more readily to the action of the electrolytes used than do the other clays tested.

North Carolina and Florida kaolins have greater initial viscosity than the other kaolins tested.

Delaware kaolin is more strongly affected by hydrolyzable than by neutral salt solutions.

NaCl, $MgSO_4$, and $CaCl_2$ do not have a very marked effect on the viscosity of any of the clays tested except the North Carolina kaolin.

In any further work along this line of research the writer would suggest that a brass viscosimeter having a 5/32" orifice be used in order to secured slightly more accurate results. The 5/16" orifice should be used in testing slips of higher initial viscosity.